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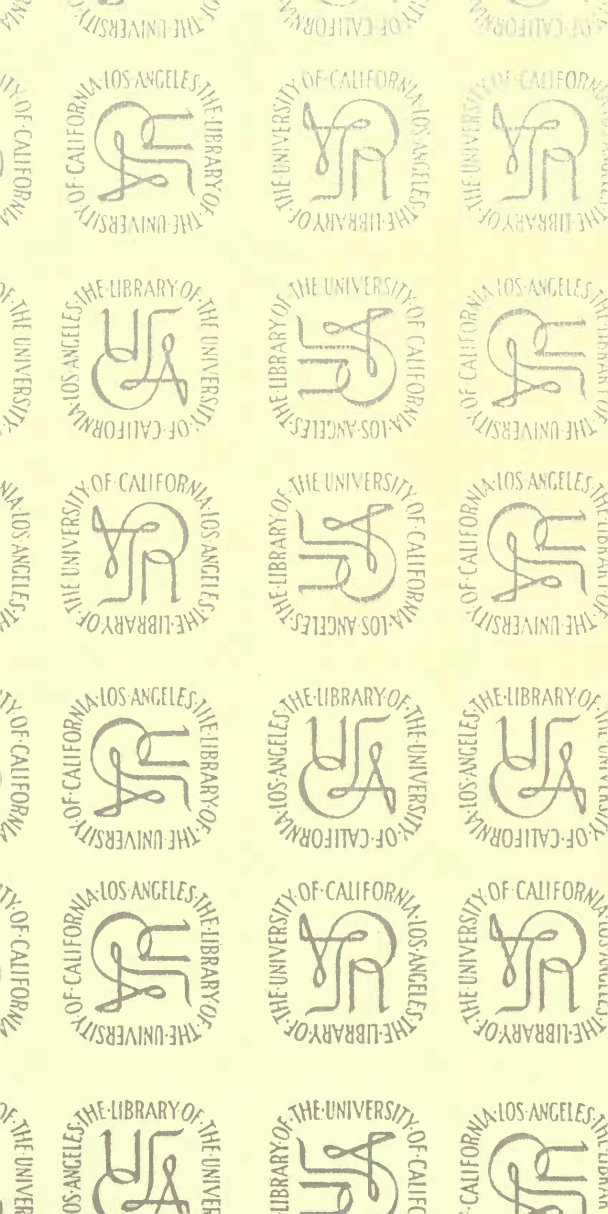
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Miss Margaret Montgomery
July 6th 1905.

A

SERIES OF ESSAYS

INTRODUCTORY

TO

THE STUDY

OF

NATURAL HISTORY.

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IN TWO VOLUMES.

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PREFACE.

THE materials, of which the present Essays are composed, were originally collected, as mentioned in the preface to "A Series of Popular Chymical Essays," with a view of delivering a course of Lectures on Chymistry and Natural History. The author's first intention being frustrated by professional engagements, he has thrown them into the form of essays, and respectfully offers them to the public in this dress.

It is the author's intention to make his readers acquainted with the full extent and

important advantages of the study of Natural History; and, by selecting many useful as well as interesting topics of inquiry, to instill into the reader's mind a thirst for further knowledge, and for a more intimate acquaintance with the science. It cannot therefore properly be called an elementary work, though it contains a concise view of the classification of natural objects; neither does the author profess it to be a system of Natural History.

It is calculated rather for the general reader, who desires only to be acquainted with the extent of the science, its general divisions, and the particular objects of inquiry which each branch comprises. And the author flatters himself that it may with advantage be put into the hands of young students, to prepare them, by a general

glance at the whole science, for a more serious application to any one department in particular.

The author has been anxious through the whole work to impress the reader's mind with the *utility* of the science: he has endeavoured to draw him from application to the mere classifying and arranging of natural objects, by pointing out a variety of important subjects for his investigation; and by connecting with it pleasing views of the plans of Providence, and occasional moral reflections.

Should it appear that those naturalists are treated with too much severity, who confine their pursuits to the collection and arrangement of plants, insects, shells, or fossils; or that the founders of systems,

and the inventors of an appropriate and accurate language of the science have not been mentioned with sufficient acknowledgements of their great merits; let it be attributed to an earnest desire that young students should be taught to consider classification as a help merely, not as the ultimate object of their pursuits. The author has a very high sense of the merits of the great Linnæus, and of all who by their assiduity in collecting and comparing specimens in Natural History, are extending and correcting our knowledge of Nature. But now that we have so good a guide, and now that so few who pursue this study can hope to improve or extend its limits, it is surely right that their attention should be turned to other, and those important and improving, subjects of investigation.

Should any readers likewise be led to suppose that the subject of natural theology is too frequently introduced, or that the same thoughts on that subject are too often repeated, they are requested to *consider* how highly necessary it is to bring the younger students to a habit of constantly connecting such views with the science we are treating of, lest by admiring the productions of Nature without at the same time contemplating the Creator, they lose the most important benefit of their studies.

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ESSAY I.

(INTRODUCTORY.)

" And yet was every faultering tongue of man,
" ALMIGHTY FATHER! silent in thy praise,
" Thy works themselves would raise a general voice,
" Even in the depths of solitary woods
" By human foot untrod, proclaim thy power,
" And to the quire celestial *Thee* resound
" Th' eternal cause, support, and end of all.

THOMSON.

THE OBJECT AND UTILITY OF THE STUDY OF NATURAL HISTORY.

THE study of Natural History has been unfortunately confined by many to the mere classification of natural objects; and, to obtain a knowledge of the distinctive characters of individual productions, has been thought to constitute the whole object of the naturalist's pursuit. How erroneous, how unphilosophical the notion! Can the botanist be content with learning the class and order of a plant? Will he not investigate its habits; the soil in which it grows, the time it flowers, its mode of propagation, whether by seed, by sucker, by runners like strawberries, or by

a bulbous root, as the tulip? And will he not endeavour to discover its uses, and detect its qualities? Surely these things are included in the study of natural history, and form indeed its most essential part; to which arrangement of natural productions is only a step, to assist in its attainment.

Many, who call themselves naturalists, and wish to be considered as such by the world, have confined their pursuits to the collection and arrangement of their plants, their birds, their insects, or their shells; and have thus brought undeserved obloquy and derision on this interesting and improving science. But how enlarged, how entertaining, and how useful a study it really is, may be easily conceived from the short sketch which I am now about to give of its object and utility.

The *object of natural history* may with propriety be divided into two heads. The first, though, as I before said, not most important, teaches us the characteristics, or distinctive marks of each individual natural object, whether animal, vegetable, or mineral. The second makes us acquainted with all its peculiarities, as to its habits, its qualities, and its uses.

To assist us in attaining the first, it is necessary to adopt some system of classification, in which indi-

viduals, that agree in particular points, may be arranged together. This very essentially lessens the labour of acquiring a knowledge of this department of natural history.

The knowledge of the distinctive characters of individual objects, which is thus to be acquired by means of classification, is necessary, to prevent confusion in studying the second branch of natural history.

Without this knowledge we might make important discoveries, which we should be unable to communicate to others; and the information of one race of naturalists would be wholly lost to succeeding generations.

A knowledge of the second head is only to be gained by a patient investigation of each particular object; for it requires continued attention and observation, to make ourselves acquainted with the whole history of a single individual production. It is on this account that we know so little of the peculiar habits and manners of many animated beings, whilst we easily ascertain their distinctive characters, and learn where to arrange them in our artificial systems.

Let us now prosecute the view we have here

taken of the subject, by an observation upon each of the three grand divisions of Nature, called the animal kingdom, the vegetable kingdom, and the mineral kingdom.

1. In *Zoology*, or the natural history of the animal kingdom, it is necessary to ascertain both the distinctive characters of each individual animal, and its peculiar habits, properties, and uses.

The naturalist first learns that the sheep, for instance, is in the class mammalia, being one of those animals that suckle their young, in the order pecora, because it is hoofed, and has no cutting teeth in the upper jaw; and that it is distinguished from other animals of the same order, by its having several blunt wedge-like incisive fore-teeth in the lower jaw only, hollow reclined horns, and no tusks.

This information would satisfy many, who call themselves naturalists; but it is far from being all that is required: the philosophical investigator of Nature inquires into its habits; as its food, its period of gestation, its season of lambing, the weather and climate most suited to its health and vigour. He endeavours to learn what produces the difference in its fleece, whether climate, food, or some peculiarity in the breed; and is anxious to ascertain what

variety is most disposed to fatten, and what food effects this most speedily; with many other very useful particulars.

The information of the first kind is of consequence, and even necessary in many cases; but that of the latter is most useful.

If a traveller discover an animal possessing any useful property, or producing any useful drug, if he have not the first kind of information, he gives so confused and inaccurate a description of it, that others, mistaking the animal, discredit the author's account, and the world loses the benefit of his discovery.

II. BOTANY, or the natural history of the vegetable kingdom, in the usual acceptation of the term implies only the knowledge of the distinctive characters of plants; and he who knows the greatest number, and is most accurate in determining the different species, is accounted the best botanist.

This, however, constitutes but a small part of the science; there is another distinct department, which may properly be termed the philosophy of botany, which is both more interesting, and more useful. This includes the knowledge of the structure, or the anatomy of plants; and the knowledge of the uses,

or functions of their various parts, as of the leaves, the bark, the pith, the roots, the juices, &c.; which is called the physiology of plants. It includes also an acquaintance with the soil and climate adapted to different vegetables, their mode of propagation, and the various uses to which their several parts or productions may be applied.

Botany in the first sense, which may be called practical botany, is subservient, and absolutely necessary, to the study of the philosophy of botany; for no one, that is unacquainted with the classification of plants, can either convey to others his own information, or himself receive the benefit of that of others, respecting either the structure and economy, or the habits and the uses of such plants, as may have been investigated.

If medical virtues are discovered in any vegetable production; without the accuracy of the practical botanist to ascertain, and describe the particular plant, which affords it, the discovery is often lost; or perhaps, what is worse, the virtues are attributed to a different plant, and it is only by repeated failures, and in some cases after much mischief, that the error is detected.

It is evident that the same may happen to the agri-

culturist, the dyer, or any other artizan, who has discovered in the vegetable kingdom the means of improving his art, but has not botanical knowledge sufficient, to give an accurate character of the plant, to which he is indebted for his discovery.

III. IN MINERALOGY, or the natural history of the mineral kingdom, almost half the students are of that class, who content themselves with collecting and being able to arrange systematically the minerals they meet with. But in this department of natural history, as well as the other two, which we have considered, something more than arrangement is required.

It is the man, who can analyze, and separate the component parts of mineral productions; who knows the art of assaying, and who knows *a priori* the probable site of a quarry, or a mine, and can tell the direction of a stratum of coal, or of marble, that I call a mineralogist.

The natural history of the mineral kingdom includes geology, or the data upon which are founded the different theories of the formation of the earth. It includes the knowledge of those facts, upon which the art of mining, and the art of separating and purifying metals is founded; and its object is to teach likewise the properties of those metals, as well as of

the earths, and other mineral productions, when separated, and in their simple state.

With respect to THE UTILITY OF THE STUDY OF NATURAL HISTORY, I have unavoidably given many instances of it, in considering the object of the science. I need therefore add but few others.

The grazier knows the advantage of attending to the habits and distinctive marks of our domestic animals. It is natural history, though not often studied scientifically, that teaches him what variety of sheep to prefer; by what means to obtain a variety of cows, remarkable for their quantity of milk; how to choose the stock, that is best adapted to his land, and what is the best food for them during winter.

Much benefit is likely to accrue from the attention lately paid to the cultivation of what are termed the artificial grasses. Instead of sowing his hay seeds indiscriminately, the grazier may select only such grasses as are by observation found to be most suited to his soil and cattle.

The farmer's knowledge of the proper succession of crops, the best times for sowing them, when to weed, and with what to manure, as well as how to destroy both weeds and insects, is the knowledge of

a naturalist; and surely he, who is scientifically acquainted with the growth of plants, knowing what part the soil acts in vegetation, and what is the aliment most required by them, will have great advantage over the mere empirical farmer, who has no better reason for what he does, than that his father did the same before him.

By studying the natural history of insects we learn the habits of such as are noxious and injurious, and thence derive the means of destroying them.

The mineralogist has often enriched individual proprietors of land, and benefited his country, by the discovery of mines; he is enabled to direct the planners of canals by warning them of obstacles, and his knowledge has aided the physician in ascertaining the virtues of minerals, and of mineral waters.

In the arts, a knowledge of natural history prevents that confusion, and those innumerable errors that must be committed, where the natural productions, which are employed, cannot be accurately discriminated from others.

It is to the naturalist that we are many times indebted for the introduction of foreign animals, and foreign plants, into our own country. Wheat, oats,

barley, and other vegetables, which are now become necessary to our existence, were not originally of British growth. The potatoe, now so general and so useful, was first introduced into this country by Gerard, a noted botanist, and was for some time cultivated in his garden as a rarity. The sugar-cane, the bread-fruit tree, the farinaceous palms, the flax and hemp, have all been transported by naturalists of the present day to regions where they never grew before.

Cochineal, which until lately was not even known to be an insect, has been accurately examined, and its habits noted by the naturalist. Its food is now known to be a particular species of the Indian fig, on which alone it can be made to thrive. The plant was therefore first introduced, and then the insect, into the East Indies, where they were never seen before. Both have thriven well, and we may now look forward with confidence to a supply of that expensive article from colonies of our own.

Besides the above, and many similar instances of advantage to be derived from studying the different branches of natural history, these two incalculable benefits necessarily arise to the student himself, from attending to the whole, or any part of the science; namely, a power of abstracting the mind, and rea-

soning methodically; and a habit of contemplating the Creator in his works.

The first of the two heads, into which we divided natural history, gives us the habit of abstraction; whilst the second leads the student to the contemplation of the Creator.

In studying any artificial classification, a certain degree of application and abstracted attention is requisite. A regular series of examinations, comparisons, and inferences, is necessary to attain the knowledge we are in quest of. The mind thus acquires a methodical habit of instituting other inquiries; and its reasoning powers become thereby gradually strengthened. I find a plant, for example, and wish to learn its name, and the place it holds in Linnæus's arrangement of the vegetable kingdom. I first examine its antheræ (a part of the flower, upon the number and position of which depends his first division of plants into classes); I compare these with the characters of his first, second, third, and following classes, till I find the one with which it exactly tallies. My inference now is, that I shall find it in this division of his system; and I have thus abridged my labour to a twenty-fourth part; for that is the number of Linnæus's classes, or first divisions. I now proceed by examining other parts of the plant,

and comparing them with the characters of his orders, and his genera, which are subdivisions of his system. I have now reduced my investigation to the species only, of which there are seldom many; and by continuing my comparisons, I soon find the name and description of the very plant I sought for.

The frequent repetition of such inquiries cannot but improve the mind; and teaching us the great utility of method, will fix a habit of abstraction, and methodical investigation.

In studying natural history, we are necessarily observant of minute distinctions, which general observers constantly overlook. How many hundred plants, and insects, are passed by every day unnoticed, each of which attracts the naturalist's eye, and furnishes a subject for his investigation. This nice attention becomes a habit too, and the accuracy of the naturalist is generally apparent in his other pursuits.

How natural, how unavoidable I may say, the transition from investigating the work, to contemplating the Creator!

Examine the structure or anatomy of any one of Nature's works, search the uses of each part, the necessary connection of the whole, and see the de-

rangement that would follow, were any one part absent, or in any way different from what it is. Ask yourself this question; had I the same materials before me, of which this animal, or part of an animal, is formed; and were I desired to produce the effect that is here produced, could I form such an animal, or such a part, possessing the same properties as this before me possesses?

Compare the eye of an animal with an optical instrument that most nearly resembles it; where will you find the power of adjusting itself to objects at different distances, that the eye possesses? where the contrivance for cleansing and preserving itself fit for use, that the tears and eyelids exhibit? And where that most wonderful property of all, sensation, by which we are informed of the objects, from whose surface the rays of light enter the eye, and strike the retina?

Compare the heart, the lungs, or any other part of the animal machine, with any thing that our best mechanics could invent to answer the same purpose. How many excellencies does the former exhibit, which the latter can never imitate?

Suppose that a machine is formed with four partitions, answering to the two auricles and two ven-

tricles of the heart; suppose, too, that like the heart it is capable of receiving and expelling one ounce of blood four thousand times every hour; can you conceive that this machine, of workmanship so fine, as not to exceed the heart in bulk, will continue its work, night and day, for sixty, seventy, or even eighty years, without repair? Or can you suppose that it could be made to possess within itself the power of repairing its waste; and that, too, without ceasing one moment in its action? How much more wonderful then it is, that the heart should do all this, whilst the case that contains it is almost constantly in motion; sometimes inverted in its position, at other times placed on its side; at one time carried slowly and evenly along, but oftentimes jostled and tossed about, or carried forward with great velocity.

After thus examining one or two instances of Nature's works, and comparing them with the productions of our most ingenious artists, with all their contrivance and experience, how is it possible not to admit intelligence and design in their formation, and, of course, an intelligent designer and artificer for their Maker?

When, moreover, we consider, that the instances which we have adduced are by no means the most astonishing; and that there are millions of such

works by the same artificer; can we deny him the attribute of omnipotence?

All the attributes of the Deity are deducible from observations respecting his works, and consequently from such as occupy the mind of the thoughtful naturalist.

Who can observe, without admiration, the infinite variety that exists, both in the animal and vegetable kingdom, and yet the remarkable uniformity amongst the individuals of the same species?

Plants and animals, that never attract the notice of a common observer, continually catch the attention of the naturalist, every one of which affords innumerable marks of wisdom, and some fresh instance of beneficence in the Creator.

The smallest insects are endowed with propensities and powers for their own comfort and preservation, and are in some way or other made useful, and perhaps even necessary to the comfort and preservation of other animals. The bee, that has never known a winter, provides against its approach by laying up its store of honey. The ephemera, that lives but for a few hours, is endowed with wisdom to procure safety for its future progeny. The former

furnishes man with a delicious condiment, and an exhilarating drink; and the latter, by dropping into the water, from whence it took its flight, affords a delicious feast to many of the finny tribe.

The history of the bee would open a field for reflection which a volume would not exhaust. I shall notice only the form and size of the cells of its comb, which exhibit marks of superior skill. The whole comb is made with mathematical exactness, is divided into small cells, and every cell is hexagonal. Why are they small? To preserve the honey from fermenting and being spoiled, which must unavoidably take place, if kept at a temperature equal to that of the hive, and in large quantities. Why are they hexagonal? Because no other regular form, except squares and triangles, would exactly fill up space; and hexagons admit of their being most capacious in a given compass.

Who can notice these things, and not allow infinite wisdom, power, and goodness in the Creator? Let the Cartesian philosopher study but the history of a bee, or the economy of a moss, and his doctrine, teaching that these things are the effects of the fortuitous concourse of atoms, must inevitably give way to the innumerable proofs which they contain of design and wisdom.

ESSAY II.

ON THE THREE KINGDOMS OF NATURE.

GENERAL OBSERVATIONS ON ZOOLOGY.

In the first Essay we have treated generally of the object and utility of the study of Natural History. We are now to commence our consideration of the different departments of the science; and to make such observations on each, as may be thought best calculated to elucidate the study, and give to the reader a general idea of what each comprises. This will be done in regular order, according to the system of Linnæus, to which an almost universal preference is given.

After such general observations, we shall select in each department some few subjects for particular investigation; and make cursory remarks on others; in doing which, we shall endeavour to join amusement with instruction. But we shall first premise some few observations on the grand division of Na-

ture into the three kingdoms, animal, vegetable, and mineral.

This division is universally received, as perfectly consistent with Nature; and is by most persons thought to be so clear and distinct, that they suppose it to be impossible to mistake in referring any particular object to its proper kingdom. This arises from their having noticed only such objects as bear evident marks of the division to which they belong; but draw their attention to a variety of other individuals, and they will acknowledge themselves to be incompetent to the decision, or will erroneously refer to one division, what has, after accurate examination, been determined to belong to another.

There is one whole class of productions, called zoophytes by naturalists, which seem to form the connecting links between the different kingdoms. They are animals of the polypus kind, mostly covered with a calcareous crust, differing little in composition from the shells of lobsters, shrimps, and other shell fish; and formed like them from an exudation, or secretion, on the surface of their bodies. These polipi are connected together by thousands or even millions, and assume a great variety of appearances according to their arrangement; the same species,

however, always assuming the same, or very nearly the same appearance. Some are connected together in the form of stem and branches, as the flustra, sertulariæ, corallinæ, and others; many of which have their offspring in the egg state attached to them, and so situated as to bear exact resemblance to the seed vessels of plants. These are altogether so like to many of the sea-plants, as to be generally confounded with them under the title of sea-weeds; but the attentive naturalist may, by examining them in their natural state, perceive the tentacula, or feelers of each polypus extended in its search for food, and hastily retracted within its shell upon the least alarm. Many of this description are found attached to oysters or other shell fish; and often to stones and pebbles, which are covered, or occasionally wetted, by the sea.

Other zoophytes assume less regular figures, and are much more firm and solid, resembling the productions of the mineral kingdom. Madrepores and millepores, called often brainstones, are of this kind. At first sight they look very like stones and pebbles, or like pieces of chalk or marble; but on an accurate inspection any one may perceive marks of an organic structure; and when they are in a recent state, detect the inhabitants of their numerous cells.

The above examples would suffice to prove, how insufficient is either a hasty examination, or the judging by similarity of appearance, for determining to what kingdom of Nature any particular object belongs; but there are many other productions, to which few persons could without hesitation assign their places. For instance, where would you arrange the green powdery substance so common on paling; the spotted or streaked appearance on stones; the mould on cheese; or the green jelly-like matter that floats on the surface of stagnant waters? Naturalists in general have assigned these productions to the vegetable kingdom; but Sennebier, and a few others, have maintained that some of them are animals.

The most philosophical notion which we can form on this subject is undoubtedly this; that the division of natural objects into three kingdoms is artificial; and that Nature, acknowledging no such bonds, passes imperceptibly from the animal to the vegetable, and from the vegetable to the mineral world, without defining where one ceases, or where the next begins. It is a just and truly philosophical observation, "*Natura non per saltum movet.*"

As the appearances of natural productions are insufficient, so are their properties or powers, for determining which are animals, or which vegetables,

according to the received acceptation of the terms. If locomotion is allowed to be the characteristic of an animal, where will you place the oyster, or the zoophytes, of which we have just been speaking; or where some species of *ulva*, and *conferva*, plants that swim about detached in water? If feeling, or sensation be the test, who shall decide that the sensitive plant *(mimosa of Linn.)* possesses it not? and who determine that the petals of the catch-fly *(dionæa muscipala)*, when they contract, and catch the fly as soon as it alights, do not feel the despoiler that comes to rob it of its honey?

Notwithstanding these imperfections in the grand division of natural objects into animal, vegetable, and mineral; consider it as merely artificial, and we shall find it sufficiently accurate for all useful purposes, nor will the adoption of it lead to much error or inconvenience.

We now proceed to the consideration of the animal kingdom, the study of which is termed Zoology.

ZOOLOGY.

Zoology is a comprehensive term, including the study of natural history in a variety of its branches.

It comprehends indeed the whole of animated Nature, exclusive of the vegetable kingdom. The immense variety of its objects makes it necessary to divide the subject, and subdivide it through four or five series, before the individuals which it comprises can be particularized.

The system of division, or, as it is termed, of classification, which we shall adopt, is that of the celebrated Swedish naturalist, Linnæus, before mentioned.

The first division of zoology, or of the animal kingdom, is into six classes. The first class, called *mammalia*, from its comprehending all animals that suckle their young, includes man, quadrupeds of every description, whales, seals, &c. The second, *aves*, includes all the feathered tribe. The third, *amphibia*, comprehends serpents, lizards, and all animals commonly called reptiles; it includes likewise the lamprey, skate, thornback, catfish, dogfish, sharks, and some others, which are usually denominated fishes; for these, as well as reptiles, are amphibious; being so constituted, as to be able to live for some time either in or out of water. The fourth class, *pisces*, includes fishes properly so called. The fifth, *insecta*, insects of every kind; amongst which are arranged the lobster, crab,

shrimp, and some others, as having two antennæ, or feelers, improperly called horns. The sixth and last class, *vermes*, includes not only worms, but most kinds of shell fish, both of fresh and sea water; slugs also, and some other animals.

Before we proceed to treat of the different branches of zoology separately, it may perhaps prove interesting, to make some general observations on this most important grand division of Nature.

The immensity of Nature is no where so conspicuous as in the animal creation.

> "Full Nature swarms with life, one wondrous mass
> "Of animals, or atoms organiz'd,
> "Waiting the vital breath, when *Parent-Heaven*
> "Shall bid his spirit blow."
>
> THOMSON.

Whether we consider the vast variety, the complicated structure, or the powers with which they are endowed, the animal kingdom far exceeds either of the other two.

The number of plants already discovered is very great; more than thirty thousand have been described, and arranged in our systems of botany; and when we reflect how many thousands of leagues have never

been explored at all by any botanist, and how many more but cursorily examined, we cannot doubt but that great numbers, probably more than half of all the vegetable productions, remain still unknown. And yet how small is the proportion of distinct species of vegetables to that of the animated beings which are formed to feed upon them! There is not, perhaps, a single vegetable but what has its peculiar insect attached to it, which can live upon no other; or at least we may advance, that there is for every plant some insect which gives it a preference, and particularly affects it. The *papilio urticæ*, or common red butterfly, chiefly affects the nettle, on which its black caterpillars are seen by scores together, being of that kind which are gregarious. The white butterfly, in the caterpillar state, in which it is green spotted with black, lives on the cabbage, on which it frequently commits astonishing depredations. The *phalæna verbasci*, one of the full-bodied moths, inhabits the *verbascum*. Hundreds of the beetle tribe live each on some particular plant; as a yellow and blue spotted one, on the asparagus; some very minute ones of the *genus chrysomela*, or of that of *staphilinus*, in different species of fungi. A little green one affects the horse-radish leaf, and another the dock.

Besides those insects, which live solely or chiefly

on one species of plant, there are many which may be termed general feeders, as the earwig, that is found in almost every kind of pulpy fruit, when ripe; the bee, that sips its honey from an hundred different flowers; or the locust, that has by its numbers sometimes alarmed whole districts, and stripped every hedge and every fruit-tree of its leaves, whole pastures of their grass, and corn-fields of their rising crops.

We have not yet glanced at one half of the insects which derive their nutriment immediately from the vegetable world; for at different seasons, different insects feed upon the same plant; and the leaves, the flower, the fruit, the bark, the wood, have each their peculiar inhabitants.

Besides insects, the number of birds, of quadrupeds, and of reptiles, that peck the berries, browze on the leaves, devour the fruits, and crop the herbage, is very great.

That the variety of animals greatly exceeds that of vegetables, becomes never more apparent than when we carefully examine all the animals which inhabit, or feed upon one particular plant. The examination of the oak, the poplar, the elm, the nut, the black-thorn, the dandelion, the butter-cup, or a blade of

grass, would equally illustrate the foregoing remark.

We shall, however, take the oak. The sheep will browze upon its leaves and tender twigs; both sheep and goats will tear off its bark when young. The caterpillars of several moths devour its leaves; one of which, from its being found only on the oak, is called *phalæna quercus;* another curls itself up in the leaf; and a third attaches itself only to the under surface, where it devours the substance, but leaves the tough nerves and ribs a skeleton. Several species of small four-winged flies, called cynips, affect different parts of the leaf, leaf stalk, and bud; where, by depositing their eggs, they produce different kinds of excrescences, called galls. There are at least four distinct species of this insect, which are found no where but upon the oak.

If again we shake an oak bough in the summer season over a white cloth, we shall discover many varieties of beetles, flies, and spiders, which feed upon its bark and leaves. The very heart of its woody trunk is sometimes perforated by the caterpillar of one of the lepidopterous tribe, of the genus sphinx.

When its bark is old and decayed, we discover

under it, earwigs, snails, and insects called old sows, with many of the beetle tribe, that derive their food either from the tree, or from each other. The acorns, or fruit of the tree, are sometimes gathered for the use of man as a substitute for bread; but more frequently as food for cattle, of which swine in particular consider it as a delicious repast. The squirrel, the dormouse, and I believe many birds, are fond of the acorn; and when allowed to decay, this, like other parts of the tree, affords food to insects of the beetle tribe.

The wood itself, when in a state of decay, often harbours woodlice, the glow-worm, and the lepisma, a silvery, or lead-coloured insect without wings, that is often seen in old window frames.

From this review we may form some idea of the vast variety of animals that are supported by the vegetable world; but to these we must add thousands and thousands more that feed one upon another, from the tiger, that easily devours deer, and can even carry off a heifer, to the microscopic mites, hundreds of which are sometimes seen upon a single beetle.

The beasts and birds of prey are numerous, as to their genera or families; but Providence has wisely

ordained that they should be less prolific than other animals; and therefore there are proportionally but few individuals. Tigers and jackalls are never seen in herds, like deer; nor does the vulture, or the eagle, lay near so many eggs as the hen, the turkey, or the duck. The shark, which is the most ravenous of the finny tribe, is but now and then met with, whilst herrings appear in shoals of several leagues in length.

There are amongst animals, many kinds that live partly on animal and partly on vegetable food, as well as many that live wholly on the former; whilst the lion and its congeners, the tiger, the leopard, the cat, and others, will only eat the fruits of their own sanguinary deeds; the badger, some of the weesel tribe, and the shrew-mouse, will devour roots and grain, as well as insects and reptiles. Amongst fishes many are wholly carniverous, greedily devouring frogs, lizards, and the smaller tribes of fishes; but there are others again which derive part of their support from sea-weeds.

Amongst the amphibia and vermes, or worms, many live wholly on animals of their own class, or on insects. But it is amongst insects themselves that we shall find the greatest number of animals deriving from animals their sole support.

There is scarcely a quadruped, or a bird, but what is infested with vermin, and each of a different kind. The sheep-louse, the tick on the dog, the bot in the hide of the ox, the pigeon-louse, that of the swallow, the little black vermin on poultry, the flea, the bug, the common louse, and that which frequently infests, and indeed sometimes almost covers, the body of a corpse, are each perfectly distinct.

Besides these, there are insects that burrow under the scales of fishes, and between the lamina of oyster-shells. Millions of polypi at the bottom of the sea compose extensive beds of coral, which from their want of locomotion must be supposed to derive their nutriment from other myriads of microscopic insects floating in the water.

Other tribes are to be found in particular parts of animals only, as worms of several species in the intestines; one species of hydatid in the head of the sheep, producing the disease called staggers, and another in the liver of different animals producing diseases there. Many insects, too, are insectivorous; the earwig destroys thousands of what are called tree-lice, particularly such as are found on the stalks of rose-buds, and the leaves of fruit-trees; spiders devour flies; a family of insects, called ichneumon, lay their eggs in the bodies of caterpillars, and their

young ones devour every part of them but their skins, and thousands of little acari, or mites, suck the juices of the larger insects.

When to all that has been now said, we add, that every drop of water contains some kind of animal, that dead animals of every description, and other dead animal matter, such as cheese, tallow, leather, feathers, clothes, and a hundred other things, all give support to some insects or other, we cannot but wonder at the immensity of Nature; and, struck with awe, admire the Creator in his works. Who could have designed such an infinity of animated beings, destined to inhabit, and occupy, as it were, every speck of space, but an omnipresent and omnipotent God!! Who could have suited each to its proper habitation, and adapted its means of procuring sustenance to its peculiar wants? and who could have so balanced between the carnivorous and insectivorous animals, and those that are their prey, between the prolific powers of the latter, and the destruction of them by the former, so that no species should ever be wholly lost, and none become detrimentally numerous? Who, I say, could have thus balanced, and thus nicely adjusted a creation so immense, but a kind and beneficent, as well as all-intelligent Being!!

If a view of the variety of Nature's works excite

such sentiments as above, how much more so must an accurate examination of the complicated structure of animated beings, and of the wonderful powers with which they are endowed! It would be improper here to enter into details on this subject, but a few general observations will not, I hope, be deemed misplaced.

To form an intricate and complicated piece of machinery, requires contrivance, patience, and manual dexterity; and the more so, the more complicated, and the smaller the machine, or its various parts, are required to be. Yet what mind can even conceive of a machine, so complicated, and the parts of it so minute, as those of an animal? Arteries and veins to carry blood, lymphatics and absorbents to convey colourless fluids, nerves to propagate sensation, and to give the power of motion; and all these so ramified, and so universally distributed over every portion of the body, that not even the point of a needle can be placed where there is not both nerve and blood vessel. The pain produced by the prick of the needle proves the presence of the former; and the blood that issues clearly demonstrates the latter.

Besides these parts there are numerous bundles of fibres, called muscles, intended to produce motion; in the disposition of which are the most evident

marks of contrivance and design: some are straight, some oblique, some transverse, some stretched over pullies, some fastened to bones, others to moveable cartilages; and in short, every necessary contrivance is adopted to produce the wonderful variety of motions, of which we find different parts of this complicated machine to be capable.

What wonderful contrivance is displayed in the heart and blood vessels, by which the blood is first expelled into the lungs, there to receive an important change from the air we breathe; is thence returned into another chamber of the heart, from that to a third, and thence to every part of the body, and back by the veins to the heart again! How complicated is the structure of the eye, the ear, and, in short, every part of the animal frame! In the eye, for instance, there are three coats or coverings, and three humours, all of them transparent, that they may admit the rays of light, but all of different forms and different consistencies, and of course possessing different refracting powers. These are so adjusted as to concentrate on the small space of the retina, rays from as large a surface as possible. A power is given by the action of certain muscles to lengthen or shorten the axis of the eye, by which we are enabled to see distinctly objects very near, and objects at a distance. And by the action of another muscle the

pupil is dilated or contracted, which, by admitting more or fewer of the rays of light, enables us to see clearly in a dim light, and prevents to a certain degree the indistinctness of vision which must arise from too dazzling a light. The same organ possesses many more adjustments and contrivances, equally advantageous and equally wonderful.

But when we cease to examine the animal frame as a mere machine, and dwell upon its properties, how impossible it is to form an adequate idea of the amazing power of the Creator! What would the eye be, considered as a mere philosophical Instrument, without a power in its nerve to receive and propagate impressions to the brain? The eyes of some persons born blind are perfect in structure; but the retina or nerve wants this peculiar power.

What would the nice contrivances in the ear, for receiving sound, avail, had it no connection with the sensorium? In short, what would the brain itself exhibit, considered only as a machine of complicated structure, in which blood-vessels, the cortical and cineritious substance, and the pia mater, like a tissue of the finest fabric, are beautifully and regularly disposed? How unimportant does this mere machinery of the brain appear, compared to its sublime use, as the seat of in-

telligence and of life. The structure cannot be supposed to give it its powers, but merely to be adapted to their reception and exertion. The machine is first formed, and then endowed in an inexplicable manner with the wonderful powers, that we know it to possess, though we cannot comprehend their nature. What less than Omnipotence could effect all this!

And when again we discover that in different animals there is a difference of structure, and different powers, and a difference in the degree of their reasoning faculties, all exactly suited to their peculiar habits, and evidently designed to promote either their own or some general good; who is there that does not feel gratitude, as well as admiration, to the great Cause of all!

ESSAY III.

CLASS I.

MAMMALIA,

OR ANIMALS THAT SUCKLE THEIR YOUNG.

A SHORT description of the systematical arrangement of each class will very properly precede the few observations, that I shall make upon the individuals which it comprehends.

This first class of animals is divided into seven orders, distinguished chiefly by the number and position of their teeth.

Order 1st. *Primates* have four parallel fore-teeth and two pectoral mammæ.

2d. *Bruta,* no front-teeth in either jaw, feet armed with strong, blunt, hoof-like nails.

3d. *Feræ,* six upper fore-teeth, and two canine teeth in each jaw.

4th. *Glires,* two sharp fore-teeth in each jaw. No canine teeth.

5th. *Pecora,* no upper fore-teeth; eight under fore-teeth. Hoof divided. Horns.

6th. *Belluæ,* more than two fore-teeth in each jaw. No horns.

7th. *Cete.* No legs.

The first order contains only man, apes, including baboons and monkies, the lemaz, and the bat tribe; these being the only animals that have four upper fore-teeth and two pectoral mammæ.

The second order, *bruta,* contains the sloth tribe, the elephant, the rhinoceros, the ant-eaters, and a few others.

The third order, *feræ,* contains the following genera, distinguished from each other chiefly by the number, shape, and position of their teeth; the seal, the dog, the cat, (including the lion, tiger, &c.) the weesel, otter, bear, opossum, kangaroo, mole, shrew, and the hedgehog.

The fourth order, *glires,* distinguished by having

two large and long fore-teeth in each jaw, and no canine teeth, includes the porcupine, beaver, rat, marmot, squirrel, dormouse, jerboa, hare, and hyrax. Their feet have claws, and are formed both for bounding and running.

The fifth order, *pecora,* or cattle, as it may be translated, includes the camel, musk, deer, giraffe, antelope, goat, sheep, and ox tribe. They have divided hoofs; and have no upper fore-teeth; they are in general inoffensive; but when urged to commit violence, they do it by butting with their heads, which are hard, and generally furnished with horns, and the muscles of the neck are remarkably strong.

The sixth order, *belluæ,* includes only four genera, the horse, the hippotamus or river horse, the tapir, and the hog. These animals have hoofs, which in the horse are whole and rounded. His mode of fighting is by biting and kicking.

The seventh order, *cete,* distinguished from all other animals of this first class by the want of legs, includes four families, the whale, the narwal, the cachalot, and the dolphin. They are all inhabitants of the sea; and although they bear some resemblance to fish in external appearance, are much more like to quadrupeds in internal structure. They

breathe air through lungs, and suckle their young at their breasts.

The further division of the genera into species will not be attempted, as it would prove dry and uninteresting to general readers; and others may more readily learn this part of natural history in books professedly systematical. We shall only observe, that these divisions are chiefly regulated by the colour, shape, and size of the animals, or some such quality.

As this 1st class, Mammalia, includes all such and only such animals, as suckle their young, it may be called a natural division, and we might expect to find in it only such as bear a great resemblance to each other. This, however, is not the case; for, besides bringing man into the same class with quadrupeds, it includes whales, which in general appearance resemble fish; and bats, that more nearly approach to the class of birds; for these, it is now well authenticated, suckle their young like quadrupeds.

All animals of this class have a heart with four cavities, (two auricles, and two ventricles); and breathe through lungs; in consequence of which structure, heat is evolved during the circulation of the

blood, and they are therefore called warm-blooded animals. In the severest winter, or in the coldest regions that man or any quadruped can inhabit, the temperature of the body is hardly a degree lower than in the warmest summer, or in the torrid zone. A thermometer with its bulb under the tongue, or buried in a wound in any fleshy part of the body, always indicates a heat of 97° or 98° be the temperature of the air what it may. The process by which this equilibrium is maintained is now pretty accurately ascertained, but cannot with propriety be explained in a work of this nature, as much chymical reasoning as well as anatomical description must necessarily be introduced. I shall however be able to give some general ideas upon the subject in my cursory remarks upon the other animal functions.

To say, that in man and in quadrupeds all the animal functions are more perfectly performed than in the other classes of the animal kingdom, is perhaps equally erroneous and improper. The circulation of the blood, and the respiration in amphibious animals, in fishes, or in insects, differ widely, it is true, from the same functions in man and in quadrupeds; but the peculiarities of the former are equally necessary to the life, and equally well adapted to the peculiar habits of those animals, as are the peculiarities of the latter. Why then should we call the pro-

cess in one case more perfect than in the other? or why style one class of animals (exclusive of man) superior to others? In none could the least change be made without derangement, inconvenience, and evident mischief; in all therefore it appears, that both the structure and the functions are the most perfect that could be adopted.

As the animal functions have been most frequently and most completely examined in the human frame, this is properly taken as the point of comparison; and the knowledge of the differences of these functions in other animals may be called comparative physiology, as the knowledge of their differences of structure is called comparative anatomy.

In this view it may be more useful to learn the animal functions as performed in the human body; and for this reason I beg that what follows may be considered as referring to the physiology of man.

The circulation of the blood means the passage of it in certain ramifying vessels from the heart to every part of the body, and back again to the heart. In man and other warm-blooded animals the blood forms two circles; first from the heart to the lungs, and back again; then from the heart to every other part, and back again. This two-fold circulation may

be thus briefly described; first premising that the heart is divided into four cavities or chambers, two auricles, (right and left), placed superiorly to the two ventricles, (right and left).

About one ounce of blood received into the right auricle is propelled into the right ventricle; and thence, by its muscular contraction, into a large vessel, called the pulmonary artery: having now left the heart, it is forced through all the minute branches of this artery, which are spread throughout the substance of the lungs; and being received by another set of vessels, the veins, is transferred through larger and larger branches into the trunk, called the pulmonary vein, and thence into the left auricle of the heart. The left auricle propels the blood into the left ventricle; and this contracting, forces it into the large artery, called the aorta. This artery by innumerable ramifications conveys the blood to every part of the head, to the arms, to the whole trunk, and to the lower extremities. Corresponding veins receive the blood from the extreme branches of the arteries, and gradually increasing in size, as they receive more and more of the blood, terminate in the large vein, called vena cava, which empties itself into the right auricle, whence we commenced our description of the circulation.

From the above statement it appears, that all the blood passes through the lungs, and returns to the heart, before it is distributed to the rest of the system. In this part of the circulation its properties are very considerably altered, in consequence of its exposure to the air, received into the lungs in breathing; to give some idea of which, I shall make a few remarks on the function of respiration.

Respiration is the reception of air into the lungs, and its expulsion; the former termed *in*spiration, the latter *ex*piration. By the action of certain muscles which elevate and depress the shoulders, protrude and draw back the breast-bone, and straighten or relax the partition which there is between the chest and the abdomen, the cavity which contains the lungs is alternately increased and diminished in all its dimensions. When it is increased, the air as naturally rushes into the lungs, as it does into the body of a pair of bellows, when by raising one handle you increase the dimensions of the cavity. And again, when the action of these muscles diminishes the cavity, the air is as necessarily expelled. So far we have explained the mechanism of respiration; but the air thus received into the lungs is essentially altered in its chymical properties. Part of its oxygen, which is the pure vital air, is absorbed;

and besides the impure part, an addition of fixed air is found in that which is expelled. This change is effected in consequence of its coming nearly into contact with the blood as it circulates in the minute vessels of the lungs; and if this reciprocal chymical action between the air and the blood is prevented by any means for a few minutes only, the animal inevitably dies; or if it is partially obstructed, disease is the certain consequence, as in asthma, consumption, and other diseases of the lungs.

The blood thus altered in its circulation through the lungs, is more florid in colour, and is fitted for the important functions which it has to perform in what may be called its second circulation. It is from the blood in its passage through different parts of the body that every thing necessary to repair the waste, and increase the growth, is to be extracted, as bones, flesh, fat, and skin; and certain fluids, as the tears, the bile, the perspirable matter, &c.: each of these is separated from the blood in its passage through particular parts, and the process by which it is done is termed *secretion*.

To supply this continual waste which the blood sustains by all these different secretions, the nutritious parts of our aliment, duly prepared by the process of digestion, are blended into one uniform

milky fluid called chyle, which is absorbed or taken up by the open mouths of certain vessels called lacteals, and poured into one of the blood-vessels, there to be mixed with, and to circulate with the blood.

This naturally leads us to make a few remarks on the process of *digestion*. Our food taken into the mouth, is there not only masticated, or ground down by chewing, but is mixed with a large quantity of saliva, or spittle; in this state it is swallowed into the stomach, is there mixed with a fluid of peculiar chymical properties called the gastria juice, and being intimately mixed by the muscular action of the stomach, is converted by a chymical process into an uniform pulpy mass termed chyme. Immediately upon its expulsion from the stomach into the small intestines, it is further altered by an addition of bile, and of a liquor called pancreatic juice, very like to saliva, which is secreted by the pancreas, or sweat bread, both which fluids are here poured into the intestines. On the surface of the stomach, and all the intestines, are the open mouths of the lacteals, which absorb the nutritious part of the chyme as it passes slowly through them, and which then receives the name of chyle. This fluid, after passing through its peculiar vessels, is poured into the subclavian vein to be mixed with the blood, and to

replenish its loss, whilst the remainder of the chyme is expelled as useless.

The blood thus altered by the chymical action of the air in the lungs, by the separation of the secreted fluids, and by the admixture of chyle, is continually passing through various chymical changes, during which the matter of heat is absorbed in a latent form from without, and is gradually evolved in a sensible form within the body, which is the cause of what is called animal heat. It would not be suitable here to enter more minutely into these chymical changes.

After this short sketch of the animal functions, the characteristics of the first class, mammalia, will be more satisfactorily understood. They are animals with warm red blood, whose heart has two auricles and two ventricles, which breathe through lungs, and have breasts for the secretion of milk, as a food for their young offspring.

The different orders of this class have very different habits, and have peculiarities in structure wonderfully adapted to those habits. The *primates*, particularly the ape and monkey tribe, are destined to live principally on fruit, and for security they lodge on trees. To enable them to climb, to grasp, and pluck the fruit, they have arms and hands much

more resembling those of man, than like the fore legs of other quadrupeds. Such as have long tails have a remarkable prehensile power in that member, and in climbing or leaping from tree to tree, can catch at a bough, and support themselves by their tails with perfect ease and safety.

The third order, *feræ*, consists of predacious animals, whose sharp hooked claws, and sharp foreteeth, sufficiently bespeak their habits. They are all endowed with a keen sight, and have strength and agility combined to dart suddenly upon their prey, and to retain it with a firm grasp.

The fifth order, *pecora*, includes the ruminating animals, or animals that chew the cud. In these the food is first swallowed without much chewing, and received into a large cavity, not its proper stomach, but a receptacle for its food, where it is retained till the animal is inclined to masticate it at its leisure. By a voluntary act the beast regurgitates, or throws up its food in small portions from this receiving stomach into its mouth, chews it, and mixes it with saliva, and then swallows it into its proper digesting stomach. There are other peculiarities in the structure of their alimentary canal, which it is unnecessary here to mention.

The seventh order, *cete*, or whales, have many peculiarities. Being warm-blooded animals, and breathing air like quadrupeds, and yet being destined to live in water, their nostrils are situated on the top of their heads, so that by rising to the surface of the water, which they are continually obliged to do, they can take in air, and expire, without raising their heads out of the water. The fat, or blubber of these animals, is entirely lodged on the surface of their bodies under the skin, serving as a warm covering, and preserving their heat, which the constant application of the cold water would otherwise soon dissipate. The limbs of the animals of this order are more like fins than like legs and feet, the two hinder ones being united so as to form a kind of horizontal tail. The intention of this peculiarity of structure is evident, it being the best adapted for producing motion in the element which they inhabit. The anterior limbs serve the same purpose as fins do to fishes, in balancing and propelling their bodies, whilst the horizontal tail is the part that by its strong lateral motion enables the animal to dart downwards to the bottom of the sea, and to rise again at will to the surface of the water.

After these few remarks on some of the orders of this class, I shall now give a few detached observations on certain families and species; with which I

shall conclude the consideration of this branch of zoology.

Of *bats* there are four species in this country; viz. the long-eared bat, the short-eared bat, the great bat, and the horse-shoe bat. They are awkward, ill proportioned animals, and seem to constitute the connecting link between quadrupeds and birds. What are called the wings of the bat, are not composed of feathers, but resemble in consistence the webs on the feet of water-fowls, and are united to its fore-legs. Its flight is laboured, and ill directed. It only flies in the evening, and that only in the summer months, retiring, as the winter approaches, into old buildings, and hollow trees, where it remains in a torpid state till spring. The female, of most of the species, produces two young at a time. In warm climates they are more numerous, and the species in general much larger. They are sometimes seen in such large flights as to darken the atmosphere, and two or three kinds of them are said to be so voracious as to attack men; and fastening on them when asleep, to perforate some large vein, and gorge themselves with blood. The bats of this country live chiefly on insects, particularly gnats, which induces them to frequent the sides of woods, or to glide along the surface of water. Other species live on fruits, and

some extract the juice from trees, especially from the palm-trees in India.

Most of our domesticated animals are in this class; some of which, as the horse, ox, sheep, and dog, being most useful to man, more particularly demand our attention; and what we shall say concerning them, will chiefly relate to their varieties, or to the peculiarities of particular kinds of horses, oxen, sheep, or dogs.

There are varieties of each, that possess distinctive characters, by which they are fitted for particular uses; and these distinctive characters may by care and attention be preserved, and thus different varieties possessing each some peculiar and useful property, may be continued. This has in some instances met with deserved attention; but in many others it has been altogether overlooked and neglected. By drawing your attention therefore to the subject, and by pointing out some advantages, that may with probability be expected to be derived from attention to it, I shall hope to stimulate some of my readers to promote the investigation.

There are two very prevailing opinions upon this subject, that may fairly be termed vulgar errors; which have considerably retarded, and do still retard

and check the spirit of improvement which we wish to see prevail. The first of these opinions is, that particular varieties of animals, or, to speak technically, particular breeds, which are common in other countries, would, if introduced into our own, infallibly degenerate, and in time assume all the characters of our native ones.

The second mistaken opinion upon this subject is, that it is beyond our power to preserve any peculiarities of breed which we may discover in animals of our own country; but that they will in time lose their peculiar qualities, and partake of those of other varieties, or breeds.

These errors originated, no doubt, from the notion, almost universally adopted, that all varieties have originally proceeded from one stock; that all kinds of sheep, for instance, have sprung from a first pair. Hence the natural inference was, that the peculiarities of different varieties proceeded from change of climate, food, or other appreciable circumstance.

Whether there was originally created only one pair of animals, which we call sheep, only one pair of dogs, and one pair of horses, is a matter of no great moment to our present question; neither is it

now within the power of man to ascertain its truth. Perhaps the wool-bearing sheep, and the hair-bearing sheep, the large draft-horse, and the Shetland poney, were created each in pairs, and some of the other varieties were the immediate consequence of an intermixture of these breeds. Leaving this hypothesis, however, and allowing, that only one pair of each of the animals, to which man now gives a distinct name, was originally created; still the inference is unjustifiable, that climate, food, or other appreciable circumstance has been the cause of the varieties, or peculiar breeds. We have, indeed, as will appear hereafter, many instances, in which it can be proved not to be the case.

From whatever cause, or by whatever power, these varieties originally sprung; I shall now attempt to prove, that they may, by proper care, be perpetuated; and that climate or food alone will not have the effect of changing one variety into another.

Every now and then we discover in a brood of sparrows, or a litter of kittens, one or more that is perfectly white, although the parent animals were both of the usual colour. The same circumstance frequently occurs amongst mice; and as these are more frequently kept for their peculiarity of colour,

I shall take them as an example, for the purpose of elucidating the subject. This is an accidental variety; at least we are wholly unacquainted with the circumstances, that have determined this variation from the usual course of Nature. But if we procure a pair of these white mice, and keep them separate from all others, their progeny will invariably be white; at least it will be as rare to meet with one of a different colour amongst them, as it is, in the natural way, to find a white one. If these mice, as is often the case, are pampered with the nicest delicacies, that those who keep them can procure, and with the greatest variety of foods, the peculiarity is as certainly preserved, as though they were at large, and met with scanty fare. White mice have been met with too in various countries, and no one has ever supposed, that, if taken to the burning sands of Africa, or to the icy regions of the north, they would sooner lose this peculiarity of colour, than they do with us. As it is with mice, so it is with other animals; and as it is with respect to colour, so it is with respect to many other, and those sometimes important peculiarities.

Many, if not all, the varieties of dogs, sheep, horses, and other animals, may, and, I doubt not, have originated from what we at first should have called accidental varieties; and the reason why some

abound in one clime and situation, whilst a different variety abounds in another, may be this; that where any variety found food, climate, and other external circumstances most adapted to its peculiarity, there that variety would remain, and would thrive, whilst others were compelled to quit it, or would gradually decrease in numbers, from the want of this adaptation of circumstances to their peculiarities.

To illustrate my meaning; suppose that a male and female dog of any breed, the Newfoundland breed, for instance, were landed on an island that possessed the advantages of variety as to climate and productions, but in which there were no other dogs. For some time none but Newfoundland dogs are bred; and in consequence of their peculiar fondness for water, they continue to inhabit the coast only; but suppose that, after some time, two or more are born, remarkable for their fleetness, and for the acuteness of their vision: these peculiarities would enable them to obtain food of a kind different from what their parents could procure; they would naturally resort to such situations as afforded this kind of food, namely the more inland parts, and would take pleasure in hunting hares, and other animals remarkable for their fleetness. In these situations they would meet, and their progeny almost universally inheriting these peculiarities, would leave the coast entirely for

the interior, would intercopulate with those of the same kind, and thus a race of greyhounds be established perfectly distinct from the original breed.

Others, born with the peculiarity of acute smell, would hunt their prey in still different situations; and according to their strength, fleetness, and some other peculiarities, would either ferret out rats, weesels, and such small animals, as the terrier does; or would laboriously follow the track of foxes, as the beagles do for many miles together. Those that possessed similar properties would resort to similar situations, and naturally associate; thus keeping up the peculiarity of the breed.

In this way the different varieties of all animals may have proceeded from accidental peculiarities in the offspring of the original pairs; and these new varieties may have been preserved, by the individuals being led, in consequence of their peculiarities, to associate with each other, and not with those of different habits.

What is commonly acknowledged with respect to dogs, has been denied in other animals, particularly in sheep; viz. that the varieties may be preserved by attending to the breeding. The pointer was, I believe, introduced into this country from Spain, and

that many years ago; he still, however, possesses the same shape and make, and same propensities as at first. That the variety of sheep, called the Spanish sheep, would as certainly retain its peculiar quality of wool, I have no doubt, were the same pains taken to prevent a crossing of the breed with others.

It is to the sportsman chiefly that we are indebted for preserving the varieties of dogs distinct; and when the grazier pays the same attention to the selection of the proper kinds, and to the prevention of mongrel breeds, we may expect to see very many distinct varieties of sheep, each valuable for some peculiar property. Many are already known, and many more might be discovered, and preserved, remarkable either for fecundity, for fattening early, for early lambing, for superior flavour, or some other valuable quality.

There are several varieties of sheep, which, instead of wool, bear hair. One of these varieties is bred in Spain, another has been found at St. Vincent's, and a third on the coast of Africa. Perhaps from their peculiarity of bearing hair, and no wool, they are not likely to be bred in this country. Their other qualities, however, being as yet unattended to, we know not what advantages they might be found to possess.

Sir Joseph Banks had one of the Spanish hair-bearing variety in his possession for several years, which preserved exactly the same properties in this country that it had in Spain.

The native sheep of Jamaica bears both hair and wool; but the former being longest, it has generally been considered a hair-bearing sheep; the wool, however, may easily be separated, and is as soft as the Shetland wool. One of this variety also was not long since alive in this country.

At the Cape of Good Hope there is a breed of Sheep, whose great peculiarity consists in having an immense broad tail; and in some part of Asia is another, bearing a large quantity of fat upon its rump.

The Spanish wool-bearing sheep is another variety, noted for the fineness, and at the same time firmness of its wool, which makes it more valuable than other kinds of wool. It was long thought, that when this variety was taken into other countries, its wool gradually degenerated, and partook of the less valuable properties of that of the native sheep. This error probably arose from the inaccuracy of the first experiments; for later trials, made upon a large scale, both in this country and in France, have

proved, that the wool continues equally fine and firm as in Spain itself, provided the breed is kept distinct; but by crossing it with others, the wool necessarily partakes of the qualities of both. It may be necessary to observe, that the wool, as well as other parts of the animal, will vary according to the state of health of the animal, and according to the quantity or quality of its food; so that sorters of wool are able to tell from the appearance of the fleece, whether the sheep was fed on rich or poor land, on high land or in meadows; but this difference is neither permanent nor hereditary, nor does the wool of one breed assume from these causes the properties of that of another.

The distinct varieties of our own country are the Southdown, distinguished for the fineness of their wool; the Dorsetshire, yielding short wool, having their bellies bare, and being remarkable for bringing early lambs; the Ryeland, being a small breed, with fine wool; the Welsh sheep, chiefly characterised by a peculiar elasticity and softness of the wool, as well as a superior flavour of the mutton; the Norfolk breed, with long legs, and black faces; the Lincolnshire, a very large breed, and bearing very long wool; the Cumberland mountain, Lammermoor, and Cheviot breeds.

These are all acknowledged to be distinct varieties; and although they probably originated from accidental births of two or more bearing similar peculiarities; yet, from such associating together, they have now established themselves into distinct breeds, inhabiting distinct districts. In the same way that Nature has led these varieties to perpetuate their kinds, uncontaminated by other varieties, so may art establish other breeds with such peculiarities as the grazier may think it worth his while to encourage. Some attention has of late been paid towards establishing a variety that will fatten well, and acquire a large size. This has been done nearly upon the same principle, only that too much attention has been paid to, what is called by graziers, good points, and good figure, and too little attention to actual experiments concerning their disposition to fatten.

It has been observed, that sheep, bearing such and such points, are most likely to fatten well; and such are therefore selected for breeding from; but it is a fact, that some sheep, which are wanting in what are reckoned good points, will turn out better in feeding than many possessing these points: And it is from such only as are observed to feed well, fatten fast, and acquire a large bulk, that selection should be made for keeping up the breed, that is, supposing this to be the only object of the breeder.

If, again, it is required to obtain a breed remarkable for fecundity, select both rams and ewes from such as were born couplets or triplets; of their offspring preserve for breeding only such as are born of ewes bearing two or three, and so on for several years, and there is little doubt but you may at last procure a breed that shall very rarely have less than two or three lambs.

If early lambing is an object, breed only from such as were lambed early; if peculiar flavour of the mutton, if any particular kind of wool, or any other peculiarity is your object, pay the same attention to breeding from such only as possess that peculiarity, and you will almost certainly obtain your end. Let it always be remembered, that the same attention must be paid to selecting the males, as the females.

To such as have not considered this subject, these speculations may appear absurd, and little likely to answer; but let them only observe what is daily taking place amongst our own species, and their doubts will cease. The different varieties of man originated probably from the same cause as those of other animals. The peculiarities of nations most assuredly depend upon their intermarrying only with each other; for in the British, French, Dutch, or other settlements, whether in Asia, Africa, or Ame-

rica, the peculiarities of the mother country still prevail. The English settler in Jamaica differs as much in visage, and in disposition too, from the Frenchman in Domingo, as the Londoner differs from the Parisian. If, however, an Englishman intermarries with a French, Chinese, or even Negro woman, their children partake of the varieties of both, and their children's children retain still less of the peculiarities of the father, if allowed to marry only with the French, Chinese, or Negro nation. Family likenesses, and peculiarities, are agreeable to the same general law.

The remarks that I have here made respecting sheep, are equally applicable to other animals, and open a wide field for the scientific grazier. A variety of the fallow deer was introduced into this country above seventy years ago, which still retains its original appearance. It is called the Menel deer, is of a reddish brown colour, spotted with clear white, and is reckoned the most beautiful variety that we have.

There is a variety of goat, called the Angora goat, which bears wool, and that of great length, fine, soft, and silky. This wool has long been sold at a very high price, as an indispensable ingredient in the manufacture of fine camlets, and bombazines;

so that it forms a considerable article of import from the Levant into this kingdom. It has generally been thought an absurdity to talk of introducing the Angora goat into this country, in consequence of the vulgar opinion, that by climate its wool would soon degenerate. A gentleman, however, of Lancashire, has tried the experiment, and he finds them to thrive well, to breed freely, and the wool to preserve its original qualities. The skin of one that was drowned, was valued by a furrier in London at six guineas, and the same price offered for as many such as he could let him have. These are a few of the many instances that might be adduced, to prove that climate has little or no effect in altering the peculiarities of different animals.

We shall now bring one or two instances of advantages to be derived by selecting such varieties of animals only as possess the desired peculiarities.

The Arab, whose livelihood, and whose very existence often depends upon his horse, has, by care and assiduity, wonderfully improved the breed in those particulars that he has reason most to prize. It is not so much swiftness, as a capability of bearing fatigue, that is required by the Arabs; and in selecting the proper objects for continuing the breed, they pay less attention to beauty of shape and make,

than to the feats they have accomplished in the way of bearing fatigue, or to what their sires and grandsires, dams and grandams, were able to perform. From attending to this peculiarity, they have so improved their breed, that an Arab would hardly think of riding a horse that could not carry him at a brisk pace for two, or even three days successively, without either eating or drinking; a task that, I presume, scarcely a single horse in this country could be found able to accomplish.

The English, however, have wonderfully improved their horses in those qualities to which they have attended; for better racers, hunters, or draft-horses, are no where to be found.

In the oxen tribe, I have no doubt but that the breed, as to fattening, might be equally improved as that of sheep; and that instead of having a large fat ox carried about as a wonder, we might in time have a whole breed, as remarkable for their size, as those which are now shewn for rarities. Other qualities besides this should be attended to; for instance, by breeding only from such cows as are remarkable for their quantity of milk, we might in time essentially improve the breed in this particular, and so of others.

As the domesticated animals have occupied so

much of our attention, we shall make but few observations on the other animals of this first class. You must not, however, from this infer that there are few others that add to the comforts, convenience, and even sustenance of man.

In uncivilized countries, thousands derive their chief support from the quadrupeds with which their woods abound. The skins of many wild beasts afford an article of traffic, and are sought as ornaments and articles of dress among Europeans.

The elephants of Africa and Asia supply all the world with ivory; and the whales of the northern seas afford an immense quantity of oil. Animals, that are never seen but as curiosities with us, are the domestic animals of other nations. The camel, the buffalo, and even the elephant, are beasts of burden in other countries. In parched and burning sands, where no European animal could travel, the patient camel carries his load from day to day, requiring but little food, drink, or rest. The broad-hoofed buffalo drags the plough in marshy miry soils, where our English draft horse could hardly move. And lastly, the elephant is trained by the native Indians to carry the heaviest burdens, and to act against their enemies in battle.

In our own country we have useful animals of the class mammalia, besides the domesticated ones. Hares and rabbits, besides supplying us with a delicate food, afford their furs to be manufactured into hats. The fox's fur and brush are made into other articles of dress.

The wolf and the fox are classed by naturalists under the same genus with the dog; as the tiger and the leopard are classed with the cat, between which there is certainly a considerable similarity of manners, as well as of appearance. But when naturalists or philosophers attempt to prove that some varieties of the human species are nearly allied to the simiæ, or apes, I cannot help thinking that such men, propagating such notions, debase themselves thereby, and become more upon a level with the brutes of which they speak, than are the poor African and South Sea Islander, whom they endeavour to depreciate.

I have heard arguments, founded on such a notion, advanced even by intelligent men, to support the propriety of the slave trade; a commerce that must cause every feeling heart to sicken at the sight, or even at the recital of half its miseries; and which would, if like were paid for like, draw forth tears of blood from every man, that dares to be concerned

in, or to encourage it. 'Tis true that the Negroe differs in the colour of his skin, and the consistence of his hair; so does the goat of Angora from the goat of Wales, in the colour and consistence of its fleece, yet both are goats; and so is the African as much a man as the Guinea trader, or the British merchant; and in the practice of morality, often comes nearer to the character of a good man. 'Tis not because the black man differs from the white in external appearance, or internal qualities, that a Christian nation tolerates his slavery; but it is because the white man has extensive power, and the uncivilized Negroe none. Is there not as much difference between the figure and habits of a Chinese peasant and a British artizan, as between the latter and a native of the coast of Guinea? And who ever heard the propriety supported, of carrying on a slave trade at Canton, or Pekin, to supply our Indian possessions with Chinese slaves? No one; for China has power to resist; and were that the case with the Negroes, none would be daring enough to assert, that a traffic in human flesh was reconcileable to the doctrines of Christianity.

ESSAY IV.

CLASS II.

AVES, OR BIRDS.

The study of this branch of natural history is denominated *Ornithology;* in treating which, we shall follow precisely the same plan as before; giving first a concise view of the classification of birds, and then making our observations on the whole class, on particular families, or on individual species, as to their economy, habits, instincts, or uses.

Some naturalists have, in the first instance, divided birds into land and water birds; but there are some species that cannot properly be classed with either; as the curlew, woodcock, snipe, and others; which only frequent the shores and sides of lakes, rivers, and brooks, where they wade about in search of food, but never swim like the goose, the duck, or the diver.

Other naturalists have arranged all the different

genera of birds under the two divisions of granivorous and carnivorous; but this, like the last, is too vague and indeterminate; for there are birds that live on insects alone, as the swallow tribe; others that eat both insects and grain, as the sparrow, and its congeners; some, again, devour slugs, and do not refuse grain; one bird lives on the honey and honeycomb of bees; and another perforates the bark, and sucks the sap of some species of palm. Under which, then, of the above two heads, can these, and a variety of other birds, be classed? Nature will not be shackled. For the purposes of arrangement we must be content without any one grand division, and consider the whole feathered race as classed into the six following orders, according to Linnæus: 1st, *Accipitres*, or the rapacious kind; 2d, *Picæ*, or the pye kind; 3d, *Anseres*, the goose, or duck kind; 4th, *Grallæ*, or the crane kind; 5th, *Gallinæ*, or the poultry kind; and 6th, *Passeres*, or the sparrow kind.

ORDER I.

ACCIPITRES.

THE birds of this order have hooked bills, the superior mandible near the base being extended beyond

the inferior, and in some it is armed with teeth. Their thighs are muscular, and claws hooked, and strong. This order contains four genera; 1st, the vulture; 2d, the falcon, which includes also the eagle and hawk tribe; 3d, the owl; and 4th, the lanius, or butcher bird.

ORDER II.

PICÆ.

THIS order, the pies, includes twenty-three genera; the crow, roller, cuckoo, wryneck, woodpecker, kingfisher, hoopoe, and many others. The bill of these birds is convex and compressed.

ORDER III.

ANSERES.

THE birds of this order are the water birds, according to the division of some naturalists. They have smooth bills, broad at the point, and covered with a thin membrane; the tongue is fleshy, the legs are naked, and the feet webbed. There are thirteen genera in this order, some of which are the swan,

which genus includes the goose, duck, widgeon, and teal; the awk, or penguin; the puffin, and the corvorant.

ORDER IV.

GRALLÆ.

THE birds of this order have somewhat cylindrical bills, tongue entire and fleshy, thighs naked, toes divided, and tail short. It includes twenty genera; the heron, curlew, woodcock, snipe, ruff, lapwing, sandpiper, dottrel, coot, and bustard, are all in this order.

ORDER V.

GALLINÆ.

THE bill in these is convex, the superior mandible vaulted over the inferior, the nostrils are half covered with a cartilaginous membrane. The toes are divided, except at the last joint, where they are connected by a membrane. There are ten genera in this order; they bear considerable resemblance to each other in general appearance as well as in man-

ners, as the pheasant, black game, moor game, partridge, and the domestic fowl.

ORDER VI.

PASSERES.

This, the sparrow tribe, have conical sharp-pointed bills, and wide naked oval nostrils. It includes seventeen genera. The pigeon, lark, starling, fieldfare, chatterer, bulfinch, linnets, sparrows, swallows, wagtails, and the nightingale, as well as all our other little songsters and warblers, belong to this sixth division.

In our general observations on this class of animals, we cannot avoid noticing, in the first place, the admirable contrivances throughout the whole of their structure, for promoting their buoyancy in the air, for enabling them to move with celerity, and for directing their course.

Their covering is of the lightest kind; yet the down, with which they are supplied under their feathers, is the warmest that could be devised; for, in consequence of the air entangled as it were in its interstices, it is one of the slowest conductors of heat.

The outer feathers, by their slanting disposition, and their natural oiliness, form a complete shelter to the body from wet; and the hollow structure of the wing feathers, by increasing their bulk without increasing their weight, renders them more buoyant in the air.

The whole form of the body is adapted to its flying with ease and celerity; the small head and sharp beak for diminishing the resistance of the air; the great muscular strength, as well as expansion of the wings, for impelling its body forward with celerity; and the broad feathers of the tail, moveable in almost every direction, for steering its course, like the rudder of a ship.

The disposition of the lungs along the back bone, and their communication with the cells in the bones of the wings, thighs, and breast, by admitting air into almost every part of the body, increases the buoyancy of the whole; and enables the bird to exist longer without breathing, which must be in a great measure impeded, if not suspended, during some of its most rapid flights.

It has been observed, that the brilliancy of plumage in the feathered tribe is only to be looked for in the warmer regions of Asia and Africa; but whoever

has seen the beautiful kingfisher dart along the shaded brook, cannot allow that Britain has nothing to boast in the brilliancy of its birds. The crimson crown, and variety of colours of the green woodpecker, the beautiful bars of black, blue, and white, on the greater wing-coverts of the jay, and the elegant plumage of the pheasant, as well as the extreme beauty of the roller, and the Bohemian chatterer, which sometimes visit us from countries still further north, prove that Nature has not confined her works of elegance to regions within the tropics.

The whole class of birds differs essentially from all other animals in internal structure, as well as external form and appearance; and every point of difference, when accurately examined, is evidently adapted to their peculiar habits. These, however, we shall not particularize, as the description of them must necessarily be minute, to be at all intelligible.

The remarkable differences between the different orders of birds, may with propriety be noticed; and we shall in every instance be able to point out some advantage that is derived from the peculiarity of each; than which nothing can be a stronger proof of design and wisdom in the *Maker*.

The general appearance of the *Accipitres*, or birds

of prey, bespeaks their character, and their mode of procuring sustenance. Their beaks are hooked, strong, and notched at the point; and the neck strong and muscular, to enable them to strike their prey with force. Their legs are short and muscular, and their talons sharp and crooked, to force down, and keep their prey upon the ground, or to grasp it in their claws, and soar away with it. Their sight is so piercing, that oftentimes, when so high as to be out of human ken, they can descry their prey upon the ground; and their flight is so rapid, that they can dart upon it with the celerity of a meteor. Their prey varies, according to their strength and rapacity, from the lamb or kid, which the vulture bears away in his talons, to the smaller birds and mice, on which the hawk and owl tribes feast.

To prevent the depredation that they would otherwise commit, Nature has ordained that this tribe of birds should be the least prolific; few of them lay more than two eggs.

The farmer ought never to disturb the owls that frequent his barns, for the number of mice which they destroy is immense. They devour the whole animal, and have the power of afterwards rejecting the skin and bones in the form of balls or pellets, which are frequently found in vast heaps in hollow

trees, or other haunts. As mice, the chief food of the common owl, come out in the evening only, and are very nimble, as well as easily alarmed, Nature has given the owl a peculiar structure in the eye, by which it is enabled to see with much less light than other animals; and from the same cause it is almost blind in a strong light: and this bird is moreover enabled to fly with less noise than any other, and of course with less danger of giving the alarm to its prey, in consequence of a peculiar softness of the feathers, and a serrature of their external edges.

The second order, *Picæ*, includes birds of very different habits, and therefore they have no great peculiarities of structure in common. Some of them feed on grubs, worms, and insects; as the rook, the starling, and others: some on fruit, and berries; as the magpie, jay, and fieldfare. The king-fisher lives on fish; and the woodpecker on insects, which it is enabled to detect, and procure from behind the bark of trees; for this purpose all the woodpeckers are furnished with large strong wedge-shaped beaks to penetrate the tree, and long taper tongues, with a hard bony substance at the end, to extract the insects and their eggs. The humming bird extracts its food from flowers, with its forked tongue, while on the wing. In this particular, and in its mode of flight, it very much resembles a lepidopterous insect

of the genus sphinx, and may therefore be considered as one of the connecting links in Nature's chain.

Rooks are remarkably fond of the grubs of beetles, particularly of the cock-chafer; and by the destruction of this injurious insect, they more than repay the farmer for any mischief which they may do his grain. Indeed they ought rather to be encouraged, than driven away from new sown land; for it is to the springing crop that grubs and slugs are particularly detrimental, and especially in land first ploughed up from the sward. It has been observed, that the destruction of a rookery has been followed by the destruction of whole crops in the neighbourhood, in consequence of the immense increase of grubs and slugs.

The third order, *Anseres*, comprehends all kinds of water fowl. The webbed feet of these birds are admirably adapted to aid them in swimming; and the greater quantity of oil secreted by the glands near the tail, and rubbed by means of their bills over all the feathers of their body, enables them to live on the water, without ever being very wet.

They live mostly on fish; and some of them have been occasionally tamed, and trained to the catching of fish for the use of their masters. The cormorant,

in China, has been put to this use ; and a ring being fastened round the neck of the bird, to prevent its swallowing its prey, it has been taught to bring all it catches to its master, in hopes of receiving at last its accustomed reward. The pelican, it is said, has been trained to the same use, and has brought home its extraordinary pouch full of fish. The soland goose, which visits some of the Scotch Isles annually, particularly the Bass, has a pouch somewhat like that of the pelican, though less, in which it sometimes carries to its young as many as three whole herrings at a time.

I have heard of a peculiar mode of taking this bird, which is sometimes practised at the Bass. The fowler chooses the night time for his stratagem, when whole flocks are at rest together ; but as they always have their sentinels in advance, it requires great care and caution to approach them. For this purpose he crawls upon his hands and knees with the least possible noise, till he has got near enough to seize one of them, and then as quickly as possible he catches another by the legs, and holding one in each hand, sets them a fighting with each other. If he is able to effect this, his work immediately begins ; for the whole flock, instantly upon hearing the affray, advance and join in the combat ; and siding with one or other party till the whole are engaged, they are

inattentive to every thing else that is going on. The fowler now with less caution crawls about, and destroys as many as he can. In this way he may sometimes catch two or three dozen before they take to flight.

In some of the lakes of China, where the water-fowl abound, the natives have the following ingenious mode of catching them:---For several days before they attempt to take them, many empty gourd shells are set afloat on the water, to habituate the birds to their appearance; and when they are observed to take no notice of these shells, but to swim about amongst them, a man, with one of the same kind upon his head, goes into the lake, and wades or swims amongst the birds with nothing but his head above water. He now begins his sport; and taking the birds by their legs, draws them under water, breaks their necks, and fastens them to his girdle one after another till he is sufficiently loaded, and then returns with them to the shore.

In this country another mode is adopted in what are called the decoys. Tame ducks are employed to entice the wild fowl, by calling them, and swimming before them into ponds of water, properly provided with nets to take them in. The decoys in Lincolnshire almost wholly supply the London markets

with wild ducks, widgeons, and half birds, taken in this way. Most of the water fowl are birds of passage with us; and leave the lakes of Sweden, Denmark, and Lapland, where they breed in summer, to visit our warmer climate during the rigour of winter. They fly in large flocks, and always preserve a certain order during their flight. The wild ducks generally fly in the form of a wedge, in which the foremost birds, breaking the resistance of the air, certainly render the flight less laborious to those that follow. And when the foremost are fatigued, they are observed to remove to the rear, and are immediately relieved by others.

The swan, which is of this tribe of birds, feeds almost solely on water plants. Ducks and geese extract many insects and their eggs from the water, and from the muddy bottom of pools and ponds, by filtering it, as it were, through their broad bills. The ducks sometimes catch small fishes; and geese, particularly the soland geese, which feed chiefly on herrings, derive their principal support from the finny race.

The fourth order, *grallæ*, or the crane kind, are peculiarly well adapted in their form to their mode of life. Their legs are long and naked, to enable them to wade with ease in shallow waters, and on

the shores, where their whole sustenance is to be found. Their bills are long, and in many their necks are likewise of a remarkable length, to enable them to search in moist, boggy, and marshy places, for insects, or in others to give them the power of darting their bills into the water, to seize their prey, while they are standing knee-deep patiently waiting its approach.

The heron is such a devourer of fish, as to be considered a nuisance, wherever fish is intended to be preserved. The woodcock and snipe live wholly on insects, to the taking of which their bills are very nicely adapted; and the plovers live on worms. The Bustard, which is also of this order, though differing in many respects from the rest, is the largest of the British birds. This, with a few others of the order grallæ, lives principally on herbs and grain.

The fifth order, *gallinæ*, includes the domestic fowls; and here again we must observe and admire the bountiful hand of Nature, in rendering most prolific those birds, that are best calculated for the food of man.

The common cock and hen, which now furnish our tables with such profusion of delicate and wholesome food, are supposed to have been originally

transported from India, where they are still occasionally found in a state of nature. This bird has been from time immemorial domesticated, and rendered serviceable to man. Though not found in America, when that continent was first explored by Europeans, it has by its fecundity already become as plentiful there as in Europe. The hen will, if well fed, lay annually upwards of two hundred eggs; and will rear one, sometimes two broods of chickens, of from ten to fifteen each.

America, in return for the common fowl, which she received from Europe, has given us the turkey, which is now in a domestic state all over Europe.

The turkey brings off fifteen or sixteen at a brood, but they require great care in this climate during the first few weeks.

The peacock is a native of India; the guinea fowl of Africa; and the Pheasant, though not domesticated, but living wild in our woods, is not originally a British bird. All the varieties of pheasants have been brought from the Chinese, or other Eastern nations; our common pheasant is the only one that has multiplied in this country.

The sixth and last order, *passeres*, or the sparrow

tribe, includes a vast variety of birds generally small; and amongst them are all the songsters and warblers of our groves and thickets. The food of this tribe of birds is either berries, fruit, and occasionally grain; or insects and the eggs and larvæ of insects. Nature in this, as in every other instance, beautifully adapts the means of procuring sustenance to the creature's peculiar wants; this tribe, therefore, is naturally divided into such as have soft and delicate bills, and others that have hard, conical, and sharp-pointed bills: the latter live on berries, kernels of fruit, and grain; the former, on insects.

The structure of the bill of the bird called cross-bill is in a very remarkable manner fitted for its peculiar food. This bird, which occasionally visits us in the winter, breeds in Russia, Sweden, Poland, and Germany, where it derives its chief sustenance from the seeds of the fir-cones. The upper and under mandible of its bill, curving in opposite directions, cross each other at the points; so that while it holds the fir-cone in one claw, like the parrot, it is enabled to raise each scale with its lower mandible, and at the same time to break it with the upper, and thus get at the seed.

Many birds of this order, and particularly the common sparrow, have been considered by narrow-minded

men as destructive, useless animals; and Nature has been impiously taxed with creating them with the sole intent of destroying other useful productions, without answering in themselves any one good and useful purpose. Even Buffon has described the Sparrow, as a bird that is extremely destructive, its plumage entirely useless, its flesh indifferent food, its notes grating to the ear, and its familiarity and petulence disgusting. We shall, however, sufficiently satisfy ourselves of the error of such impious declaimers, if we do but examine some of the propensities of these birds.

The sparrow, for instance, amply repays the husbandman and gardener for his petty thefts, by destroying innumerable insects. It has been calculated from actual observations, that a single pair of sparrows, during the time of feeding their young, will destroy about four thousand caterpillars weekly. Only consider, then, what myriads of these pernicious insects are destroyed annually by one species of birds.

We can hardly doubt but that the total extinction of the race of sparrows, provided the breed of other birds of similar habits was not increased, would soon prove the cause of an universal dearth. Every caterpillar, whose life was thus preserved, would, when

arrived to its perfect winged state, lay several hundred eggs, which immense increase of all the various caterpillars, that the sparrow is known to search for and devour, would in a few years be equal to the destruction of every blade of grass and every leaf.

The swallow, by its unexampled destruction of other insects that would poison the very atmosphere in which we live, preserves the nice balance that is requisite for the happiness and harmony of the whole. These birds again afford a necessary source of food to others, which answer evident and important purposes in the grand scheme of Nature.

We have now gone through the six orders into which birds are divided; noticing some of the peculiarities of each. We shall finish our essay on ornithology with some observations on the migration of birds, and some other remarkable instances of their instinct.

A great variety of birds are known to emigrate annually to a considerable distance from the country where they breed, and to return again regularly at the breeding season. The only evident inducements to these long voyages are, either to seek a more genial temperature, to obtain more abundant food,

or to find a safe retreat for producing and rearing their numerous young. How they acquire the necessary knowledge for their journey, or how they are directed to regions most suited to their respective wants, has been the subject of various speculations. But all inquiries of this sort end in doubt, and only prove that the Creator has endowed his creatures with instincts sufficient to relieve their respective wants, and to preserve their future progenies.

I shall now give some account of the birds, that have their stated times for visiting this island, naturally dividing them into such as spend their summer here; and such as come in winter, and leave us in the spring.

Of the summer birds of passage the different kinds of swallows are most numerous, and have attracted the most attention. They have so often been observed at sea, steering their course southward in autumn, and northward in spring, that no doubt can now be entertained as to the majority of them leaving us in the winter for the more genial warmth of the southern latitudes. There are, however, authentic accounts of some few being found in a torpid state, like bats, during the winter months. These individuals, probably by the lateness of their broods, or by some other accident, were necessarily

detained till after the general migration, and were then unable, probably from want of food and strength, to undertake the journey. The same circumstance satisfactorily explains the transitory appearance of a few swallows so late in the year as November, and even December, when a warm sunny day has roused and brought out some of these torpid birds in search of a little food. The bat in the same manner, though it lies torpid most of the winter months, is occasionally seen in the evening of a warm day many weeks after it has retreated to its winter lurking-place, or some weeks before it leaves it entirely in the spring. On these occasions they are sure to meet with some provisions; for the same warmth that has roused them to activity, has brought out many of the insect tribe from their winter slumbers also.

It has been observed too by naturalists, that great numbers of swallows have been sometimes seen early in the spring, have then totally disappeared for several days of cold weather, and have been on the wing again the first fine sunny day. As they cannot be supposed to have gone back again to warmer climates, and to have returned so soon, I think it highly probable, that these also have been for a few days in a state of torpor.

This disposition of the swallow to become torpid is evidently regulated by the temperature of the air, as has been satisfactorily proved by experiment. Swallows detained here, and not kept warm, have become torpid, whilst others, carefully preserved, have remained lively all winter. The torpid ones, gradually warmed, have likewise recovered their activity. That they have been endowed with this peculiarity for wise purposes cannot be doubted.

The sole food of the swallow we know to be insects, and as these only fly during warm weather, it is probable that, in a variable climate like this, these birds would occasionally suffer by being without food for a week or two together, particularly such as have come over rather sooner than the general flight, were it not for their capability of becoming torpid from the same cause that deprives them of their food.

The opinion, that swallows do not migrate, but spend their winter at the bottom of our ponds and lakes, though formerly pretty generally admitted, is too preposterous to be thought worth a moment's consideration by modern physiologists. Indeed, from the anatomical structure of the bird, it is known to be impossible for them to exist under water.

The frequent appearance of swallows on the verge of the water late in the autumn, and early in the spring, which had given rise to the above opinion, and which Mr. White notices in his History of Selbourne, makes it probable, that the transitory state of torpor, which we suppose some of them occasionally to undergo, is passed among the weeds and roots along the banks of ponds and lakes.

The other summer birds of passage, as well as the swallows, are soft billed birds, and live on insects. From this circumstance it is evident, that a want of food, as well as the coldness of the weather, impels them to their migration; for during the winter there are but few insects on the wing.

As if, however, Nature delighted in shewing the exhaustless variety of her means to support and perpetuate her creatures, she has not destined all the insectivorous birds of this country to migrate in winter in search of food. The redbreast and wren approach the habitations of men during the severity of winter; and besides the spiders, which they search for and detect in our out-houses, and the thatches of our buildings, they gladly accept a few scattered crumbs; as also does the hedge-sparrow, which almost lives on this precarious subsistence. The three species of wagtails which we have in Britain, frequent shal-

low rivulets near the spring heads, where the water never freezes, and there they procure the aureliæ or grubs of a four-winged insect called phryganea. The whin-chat, stone-chatter, golden crowned wren, and some of the wheat-ears, are the other soft billed birds, that stay with us the whole winter, and are supported on the few insects, and their eggs, that are then to be found.

As many of my readers may not be acquainted with the particular birds which only spend their summer with us, I shall subjoin a list made out by that accurate observer Mr. White, in which they are arranged nearly in the order in which they re-appear in Spring.

SUMMER BIRDS OF PASSAGE.

1. Wryneck, - - - -	Middle of March.
2. Smallest Willow Wren,	March 23.
3. Swallow, - - - - -	April 13.
4. Martin, - - - - -	ditto.
5. Sand Martin, - - -	ditto.
6. Black Cap, - - - -	ditto.
7. Nightingale, - - - -	Beginning of April.
8. Cuckoo, - - - - -	Middle of April.
9. Middle Willow Wren, -	ditto.

10. Whitethroat, - - - - -	Middle of April.
11. Redstart, - - - - - -	ditto.
12. Stone Curlew, - - - - -	End of March.
13. Turtle Dove, - - - - -	ditto.
14. Grasshopper Lark, - -	Middle of April.
15. Swift, - - - - - - -	About April 27.
16. Less Reed Sparrow.	
17. Landrail.	
18. Largest Willow Wren, -	End of April.
19. Goat Sucker, or Fern Owl, - - - - -	Beginning of May.
20. Fly Catcher, - - - -	May 12.

The winter birds of passage are such as breed in more northern climates, chiefly Denmark, Norway, Sweden, and Lapland; and which visit us, when the cold weather becomes too severe, and their food consequently scanty. The most numerous of this class are the different kinds of wild fowl, as geese, ducks, widgeons, half birds, &c., which come over in vast flocks in the beginning of winter. Many of them used to stop here in the summer, and breed with us; but since the population has increased, and the quantity of waste land has been diminished, they find the northern lakes more secure, as well as better supplied with fish for them during their incubation, and the rearing of their young. The other birds, that visit us in winter, are likewise impelled to it

by intensity of cold, and scantiness of food, and probably return in summer whence they came for the security of their young.

It is a wise provision of Nature, that directs the return of the insectivorous birds from Africa and the south of Europe, to spend the summer here, although insects still abound in the countries they have left; and the same that directs the winter birds of passage to leave us in the summer, although fish and worms, their chief support, still abound with us. Were no such migration to take place, the insects here, and fishes and worms in Lapland, would soon be detrimentally abundant.

The winter birds of passage are the redwing, fieldfare, royston crow, woodcock, snipe, jack-snipe, wood-pigeon, wild swan, wild goose, soland goose, wild duck, pochard, widgeon, and teal. Some of the last species breed in this country. The ring-ousel seems only to make this island its baiting place from a northern to a more southern country. Some have been observed here in the latter end of September, and others again in March. The crossbill, the grossbeak, the roller, and Bohemian chatterer, are not annual visitants, but appear every now and then in the winter season.

It being now necessary that we draw to a conclusion this Essay on Ornithology, we shall only glance at some remaining subjects of interesting inquiry. In the first place, the manner in which the different birds pair, warble out their amorous strains, and build their nests, will afford many hours of amusement to the observing naturalist.

> " 'Tis love creates their melody, and all
> " This waste of music is the voice of love,
> " That even to birds and beasts, the tender arts
> " Of pleasing teaches."
>
> THOMSON.

Some are by no means constant to their mates; but that male bird who has by his prowess proved victorious over the rest, considers himself entitled to the favours of numerous females; this is remarkably the case with grouse. Others, as the turtle dove, and many of the smaller birds, pair in the spring, and maintain an admirable constancy throughout the season of hatching and rearing their young. The sweet warbling of these rural songsters is chiefly confined to the male birds, and seems to be their efforts to attract and please the females.

The art of the swallow in building its house of clay, and lining it with feathers; the art also of the small

birds, that build in our hedges, in collecting moss, small twigs, and leaves, and lining their nests with feathers, or with horse hair, is extremely astonishing; whilst the partridge, alike anxious for the preservation of its young, deposits her eggs upon the bare ground in standing grass, or in the rising crops.

The attention paid by the parent birds in hatching and rearing their young, is truly interesting. The raven and the pigeon divide the labour of incubation with their mates, the one sitting close whilst the other fetches food; and this they do alternately. The common hen, and females of the eagle tribe, not only hatch the young themselves, but seem to be entirely forsaken by their mates at this interesting season; while in most other cases the male at least assists in feeding the young brood, although the females have the sole care of incubation.

The many ingenious modes that different birds have of procuring food, affords another ample field for observation; and we cannot but admire their powers, whether they be acquired by experience, or be purely instinctive. Thus the swallow will attend you, when riding in the country, and scud around your horse, to catch the insects that follow him, or that are roused by him from the grass: for the same reason broods of wagtails will play about the noses

and legs of cattle that are feeding in moist places; rooks will follow the plough, to devour the slugs and worms that are dug up; and the little redbreast will attend the gardener, when employed in digging.

These are but a few of the many interesting topics, which catch the eye, please the fancy, and improve the heart of the diligent observer of Nature's works. But it is hoped that these few will suffice to shew the importance and extent of the study, as it relates to this second class of animals, the birds. We shall now proceed to the consideration of the third.

ESSAY V.

CLASS III.

AMPHIBIA.

The distinctive character of the third class, *amphibia*, or amphibious animals, seems to be a peculiarity in the organs of respiration; these being of a mixed kind between the perfect lungs of quadrupeds and birds, and the gills, which are the respiratory organs of fishes. This peculiarity enables them to breathe in air like the former, and also to extract the same vital principle from the water, or rather from the air contained in the water, as do fishes.

The characteristic of this class being a peculiarity of internal organization, it is not surprising that the animals which it comprehends should agree more in certain propensities and habits, than in external appearance; accordingly we shall find it to contain some that resemble fishes, as the shark and skate; and others that more nearly resemble quadrupeds, as

the tortoise, the crocodile, &c.: and others, again, that in general appearance resemble no other class of animals, but have a *tout ensemble* of their own; as, for instance, snakes and serpents, some of which can move with equal ease on land or in water, though they have neither feet nor fins.

The points of agreement in the whole class are all the consequence of the above stated peculiarity in the organs of respiration. They are all cold-blooded animals, and their own heat is in a great measure regulated by the temperature of the surrounding medium; whilst that of quadrupeds, and other warm-blooded animals, scarcely varies one degree, whether immersed in water at the freezing point, or shut up in a stove heated almost to boiling. Frogs have been absolutely frozen, so as to chip like ice; and yet when carefully and gradually thawed, have been completely re-animated.

All the amphibious animals have hearts with only one ventricle; which organization is necessarily connected with the peculiarity of their breathing; and they are likewise remarkably retentive of life. A frog will live and move for some minutes after its head is severed from the body, or after its heart is cut out. The heart itself, too, may be plainly seen to contract

and dilate for some minutes after it is taken from the body.

The amphibia have no grinders, but most of them sharp-pointed teeth, and their bodies are either naked or scaly. This class is not numerous; and though we are far from admitting that any one of them has been created but for some important purpose, yet the immediate utility of most of them to man is less apparent than that of other tribes.

The class is divided by Linnæus into four orders, distinguished as follows:

1st. *Reptiles*, which breathe through the mouth, and have four feet. This includes the families of the tortoise, lizard, and frog.

2d. *Serpents*, which breathe through the mouth, but have no legs, no fins, no ears. They proceed by an undulatory motion. There are six genera.

3d. *Meantes*, having both gills and lungs. There is only one species, the Syren, a singular animal, discovered by Dr. Garden in Carolina, inhabiting swampy muddy situations.

4th. *Nantes*, which breathe indifferently through their lungs and gills, and have fins. This order is most allied to fishes properly so called: it contains the shark, lamprey, skate, and several others, which are by many naturalists classed amongst fishes. We have no general observations to make upon this class of animals, but shall cursorily notice a few individuals. Amongst the first order, reptiles, is the *turtle*, or sea tortoise, known amongst epicures of every country for the delicious flavour of its meat. It is brought from the West Indies to European markets.

The *crocodile*, so fierce and formidable an enemy to cattle, when they come to drink of the waters of the Nile, the Niger, or the Ganges, is of the same order. Its usual food is fish; but when that fails, it attacks almost any animal, and even man. Both the eggs of this animal, and the animal itself, are eaten by some of the natives.

The last animal of this order that I shall mention is the *toad*, which is unjustly detested as poisonous, and as the most disgusting of animals in its form. It is, however, certainly ascertained to be perfectly innocent; nor do I think it at all disgusting. It is, perhaps, merely prejudice, and an association of

ideas connecting its supposed venomous qualities with its appearance, that has rendered it so disagreeable to most persons.

There is a species of toad in Surinam, that shews, in a remarkable manner, the ever-varying means that Nature delights to use for accomplishing her ends, and affords a fresh instance of the infinitude of her power. On the back of the female are several hollow prominences, resembling eyes, into each of which the male carefully inserts one of the eggs as soon as the female has spawned. Here the eggs remain enclosed, but not connected with the mother till the time of their maturity, when the cells burst, and the young escape.

Of *serpents*, many are justly the objects of terror both to man and other animals. In India is an immense serpent called the *boa constricta*, often above thirty feet long, which has such strength and power as to destroy oxen, and even tigers, and afterwards to devour them whole. It has many sharp teeth, but no fangs or tusks, and it is not venomous. Its prey, however, is as certainly destroyed as if it were so; for if too large to be swallowed without some preparation, it twists itself round the animal, by a sudden contraction breaks every bone, and soon reduces it to a shapeless mass; then moistening it all

over with its saliva, it swallows the whole at once. After a repast of this kind it is unable to move for several days, and is then most easily taken and destroyed.

The venomous snakes are of a smaller size, but the bite of many of them is certainly fatal. They chiefly inhabit warm countries; and fortunately for this happy island we have only one, the viper, that is at all venomous. It is now far from being common, and the bite is easily prevented from becoming serious, by the early application of sallad oil to the part. This is the only venomous animal that is known in this island.

Of the last order, *Nantes*, many are used for food, as the skate, thornback, lamprey, and sturgeon. Isinglass is procured from a species of sturgeon caught in the river Danube. The skin, entrails, fins, and tail of this animal, are cut into small pieces, and after sufficient maceration in water, are boiled till they are dissolved, and the jelly is then dried and rolled out. It is a subject worth the experiment, to endeavour to ascertain whether the same parts of some of our own fish would not yield a similar substance.

The shark, known to all as the most ravenous of fish, belongs to this order. He is so voracious as to

swallow, without distinction, almost every thing that drops from a ship, as cordage, wood, iron, and even knives, and is thus often caught by devouring the hook baited for his destruction. He will not, however, touch any of the feathered tribe, if thrown to him; and in his otherwise indiscriminate depredations on the finny tribe, he never devours a small fish called the pilot fish. This little animal being also a fish of prey, and seeing much better than the shark, whom Nature, as a protection to other fish, has rendered almost blind, directs the shark to its prey. The shark, therefore, aware of the services of his little friend, spares his life. Another means, by which Nature has counteracted the voracious appetite of this animal, has been by making its upper jaw project far beyond the lower, which renders it necessary for it to turn on one side before it can seize its prey, thus often affording it an opportunity of escaping.

CLASS IV.

PISCES, OR FISHES.

The study of this branch of natural history is termed *Icthyology*. It is, perhaps, of all others, the most imperfectly understood, both with respect to the individuals which it comprehends, and with respect to the manners and habits of fishes in general. From the very circumstance of their inhabiting the watery element, their operations are mostly hidden from our view. We know little or nothing of their amours and procreation, of their growth or natural decay; we have learned but little of the food, the process of digestion, or the function of the gills, even in those fish that we most frequently meet with; and of the immense variety we naturally conclude to inhabit the seas of different climates, we know scarcely any but what visit the shores, and those shores only that are inhabited by Europeans.

The general form and structure of fishes is beautifully adapted to the peculiarity of their situation.

For, to inhabit an element so much heavier than air, they want not the large expansive wings of birds to buoy them up; but being themselves nearly of the same specific gravity as the water which they inhabit, their small fins are all that is requisite to enable them to move with ease, and steer their course at pleasure. The exact use of the different fins, and how accurately their position and number are adjusted, will appear by the following quotation from Dr. Paley's "Natural Theology:"

"In most fish, beside the great fin, the tail, we find two pair of fins upon the sides, two single fins upon the back, and one upon the belly, or rather between the belly and the tail. The balancing use of these organs is proved in this manner: Of the large-headed fish, if you cut off the pectoral fins, *i. e.* the pair which lies close behind the gills, the head falls prone to the bottom: if the right pectoral fin only be cut off, the fish leans to that side; if the ventral fin on the same side be cut away, then it loses its equilibrium entirely: if the dorsal and ventral fins be cut off, the fish reels to the right and left. When the fish dies, that is, when the fins cease to play, the belly turns upward. The use of the same parts for *motion* is seen in the following observation upon them when put in action: The pectoral, and more particularly the ventral fins, serve to raise and de-

press the fish: when the fish desires to have a retrograde motion, a stroke forward with the pectoral fin effectually produces it: if the fish desire to turn either way, a single blow with the tail, the opposite way, sends it round at once: if the tail strike both ways, the motion produced by the double lash is progressive, and enables the fish to dart forwards with an astonishing velocity. When the tail is cut off, the fish loses all motion, and gives itself up to where the water impels it."

Fishes in general are but imperfectly endowed with those senses that are common to most other animals. Their sense of feeling is supposed to be very dull; the sense of hearing, perhaps, none at all. Whether they smell at all, is doubtful; and that they have no sense of taste, is evident from their swallowing their food without the least mastication. The sight of fishes is the most perfect of their senses, and is, perhaps, the only one that, from the peculiarity of their situation, they have any occasion for, or could at all avail themselves of, if they possessed them.

Of their food, it is presumed that some fishes live on the vegetable productions of the sea; but in general they are carnivorous, or insectivorous, devouring one another, or deriving their sustenance from the myriads of sea insects, and their eggs, or from

the spawn of other fishes, that every where abound. Crabs, and other shell-fish, are often found in the maw of the cod; and rats have frequently been detected in the stomach of the pike. The very long abstinence that some fish have been known to undergo, or rather the small quantity of food which they have had to support them, has induced some to believe that they can derive nutriment from water alone. Pike have been put into ponds, where it has not been known that there have been any other fish, which is their usual food, and yet they have lived in such situations for years. Here, however, it must be observed, that frogs, newts, and insects, might afford sufficient food, and that of a kind which they are known frequently to devour.

All fishermen agree that they never find any kind of food in the stomach of the salmon. Herrings live in immense shoals, and yet those in the centre and the rear are found equally large, and well fed, with the foremost; which we can hardly suppose would be the case, did they live on other fish. Besides, no bait will tempt the herring, which seems to argue that its food is of another kind. Both these, and salmon, however, may derive considerable support from the myriads of minute insects, which we know to be present in sea water, and which, taken in continually, and digested almost as soon as taken,

would discover little or nothing in their stomachs, when examined.

Gold and silver fish are frequently kept in glass vessels for ornament, or amusement; and they have been known to live in such situations for several months together without being once fed, provided the water has been frequently changed. In this case it is probable that they derived some nutriment from the microscopic insects, with which all water abounds.

There is, however, great reason to believe, that fish have the power of decomposing water, and deriving real aliment from it. Nor is this the case with fish alone; for water, if properly combined, affords nutriment to man. A certain quantity of soup, for instance, will go further in supporting a family, than the whole solid matter would do, of which the soup was formed; and a bason of sago, properly prepared, than the grains of sago swallowed dry; and the barley crowdy of the Scotch, than the same quantity of barley made into bread.

The duration of the life of fishes is almost altogether a secret. Some few, however, have been known to live to a great age. Gesner asserts, that a pike was taken at Hailbrun in Swabia, in 1497, with a brass ring affixed to it, proving it to be 267

years old; and a carp has been known to live above an hundred years.

Most fish, it is supposed, are oviparous; but whether the male impregnates the spawn before or after it is deposited by the female, is yet, with respect to most fishes, a subject of dispute. Some few are known to be viviparous; one of which is a species of blenny, called on that account the viviparous blenny, which usually produces two or three hundred young ones at a time.

Most fish leave the deep and resort to shallows on the coast, or leave the sea altogether for the rivers, during the spawning season.

The salmon leaves the sea and pushes to a considerable distance up the rivers, for the purpose of depositing its spawn in safety. This it does with us in September; and when they find a place convenient for the purpose, both male and female unite their labours to make a hole in the sand twelve or eighteen inches deep, in which the eggs are deposited and lie buried till spring. The old ones return immediately to the sea, it is supposed, in search of more abundant or more congenial food. The young fry appear about the end of March, and in May leave the rivers for the sea, but return again in June or

July, grown to the size of twelve or sixteen inches in length.

In ascending the rivers, salmon are known sometimes to leap up cataracts several feet high; and if foiled at first, to repeat the attempt again and again till they succeed. These places are frequently called salmon-leaps.

The regular return of salmon from the sea to the rivers at that particular season, when they deposit their spawn, is deserving of attention; and, although a recent discovery proves it not to be an instinctive action of the fish for the preservation of their young, it is a remarkable display of inventive power, if I may so express myself, in the great Creator, who delights in multiplying his means, and in rendering every link in the great chain of creation subservient to the rest.

It is observed, that when the salmon first leaves the sea, his body is covered with a particular species of louse, which can only live in salt water, and therefore soon dies, when the salmon has entered the fresh water; after the destruction of this species, another breeds, and the salmon is soon covered again with as troublesome a guest as before; but this being a fresh water insect, is destroyed as soon as the fish

returns to its briny element. Now it is supposed, and with great appearance of probability, that the inconvenience experienced by the fish from the vermin which infests it, is the immediate cause of its leaving the salt for the fresh, and the fresh for the salt water; but still we have the same display of wisdom, and beneficent contrivance in the Creator, as we should have had, if he had endowed the salmon with an instinctive faculty to seek the stream for the immediate purpose of depositing its spawn in safety. The same end is answered, the safety of the future progeny is equally secured, and an opportunity is offered of adding two links to the chain of Nature's works, by the production of two families of insects, that could not otherwise have existed; and of thus beneficently enlarging the sum of positive enjoyment amongst created sensitive beings. Nor are the peculiar endowments or instinctive faculties of the salmon in any sort abridged by this ingenious arrangement. Some would be ready to bring this fact forward as an instance of instinct being fairly resolvable into sensation; they would say, that the uneasiness which the salmon experiences from the irritation of the insects, drives it to seek relief in the fresh water in one instance, and the salt water in the other: but who taught this fish to know, that such a change of situation would rid it of its inconvenience? Allowing that it could discover the cause of the irritation which it

felt, to be an insect, surely it cannot be supposed, that either reason, experience, or tradition, could teach the salmon, that fresh water, which was so agreeable to itself, would prove destructive to this insect. The young fry, from their very entrance into life, live unknowing and unknown by their parents, and in May perform their first emigration to the sea, returning in June or July to the rivers, without holding any communication with their parents, or their senior brethren. To what then must we attribute this propensity in the fish to change its element, but to an instinct originally implanted by the Creator for the wise and benevolent purposes above specified?

The astonishing fecundity of almost every kind of fish must not be passed over unnoticed. M. Petit of Paris found, that the roe of a carp eighteen inches long weighed eight ounces two drams, which make four thousand seven hundred and fifty-two grains; and that it required seventy-two eggs of this roe to make up the weight of one grain; which gives a product of three hundred forty-two thousand one hundred and forty-four eggs contained in this one fish. Many other fish are known to be equally prolific as the carp. The intention of so great an increase is certainly to furnish food for man, for many of the feathered tribe, for thousands of their own kind, and yet to allow enough of each species to remain for its

preservation, and for the annual renewal of the same beneficent purposes.

The immense shoals of herrings that annually appear upon our coasts, and upon the coasts of other countries as far south as the Mediterranean, have been generally described as emigrating from the North Seas; but from certain facts mentioned by Dr. Anderson in his Agricultural Recreations, this is rendered at least doubtful; and it appears probable, that they only retire further from our coasts, and sink deeper in the sea at certain seasons, re-appearing at others. The following arguments incline me to favour this opinion. In the first place the herring fishery commences sooner in some southern bays than in some others that are more northerly; secondly, there has been no return of the shoal ever observed, and no account is given of what becomes of the immense numbers that must escape our coasts in travelling southwards; thirdly, from certain peculiarities in the herrings of particular fisheries, there is reason to believe that certain breeds or herds return annually to the same shores; and lastly, they are taken on our coasts in full roe, just after they have deposited their roe, and in all the intermediate stages; so that we cannot suppose that they seek the northern seas for the purpose of spawning. This subject, however, being still an undecided point, I shall give

an account of what is supposed to be the case by those who favour the opinion of migration.

An immense shoal is supposed to issue from the seas of the north, which first divides at the northern extremity of Iceland; and whilst one half proceeds to diffuse plenty over Europe, the other steers its course across the Atlantic to convey the same benefits to the inhabitants of America. The European shoal appears off the Shetland Isles in May and June, in columns of several miles in length, and three or four in breadth. They sometimes descend for ten or fifteen minutes, and then rise again to the surface. The Shetland Isles divide the shoal into two branches; the one of which skirts the eastern, the other the western coast of Great Britain; filling every bay and creek with a valuable and abundant supply of food. The eastern division supplies likewise the shores of Denmark and of Holland; and the western sends numbers to the Irish coast. Such is the account given by ancient naturalists, and credited till the present times.

The herring fisheries in the Hebrides, in Holland, and in this country, are now carried on to a very great extent. In 1610 the Dutch employed three thousand boats in the business of catching them only. In 1782, at the mouth of the Gothela, a small river

which washes the town of Gottenburgh, 139,000 barrels were cured by salt, 3700 were smoaked, and 2845 casks of oil were extracted from what could not be preserved. Besides this great devastation committed by man, the shoal of herrings is always accompanied by fishes, and by birds of prey, by whales, by porpoises, sea-dogs, sea-calves, saw-fish, &c., which devour thousands of them daily during their appearance.

Besides herrings, cod-fish, pilchards, salmon, and many other fish, are caught for food, and what cannot be eaten fresh are dried or salted, and transported in immense quantities to distant nations.

Another use of fish, where it abounds, is sometimes made in manuring the land with them; in which way they prove highly serviceable. In some of the fenny parts of this kingdom is a small fresh water fish called stickle-back; which in certain seasons is so remarkably abundant, that they are obliged to leave their native drains and ditches, and seek the rivers; in which they form such vast shoals as to be caught in baskets or in nets, and are sold to farmers for manure.

The pike and carp, though now so common in this country, have been introduced from other parts;

the former in 1537, as is commonly believed; the latter in 1514.

As we have nothing to observe respecting the particular orders of fishes, and nothing more respecting individual species, we shall conclude the subject by a bare enumeration of the orders, and their characteristics. Linnæus divides them into four orders.

1st. *Apodes;* without ventral fins, as the eel, the conger, &c.

2d. *Jugulares;* ventral fins placed before the pectoral, as the cod-fish.

3d. *Thoracici;* ventral fins under the pectoral, as the perch.

4th. *Abdominales;* ventral fins behind the pectoral, as the salmon.

ESSAY VI.

CLASS V.

INSECTA, INSECTS.

" Let no presuming impious railer tax
" *Creative wisdom*, as if aught was form'd
" In vain, or not for admirable ends.
" Shall little haughty ignorance pronounce
" His works unwise, of which the smallest part
" Exceeds the narrow vision of her mind ?"

" And lives the man, whose universal eye
" Has swept at once th' unbounded scheme of things;
" Mark'd their dependance so, and firm accord,
" As with unfaultering accent to conclude
" That *this* availeth nought ?" THOMSON.

THE study of this branch of Natural History is termed *entomology*. It is a study which may be considered as in its infancy. So prone is man to look with contempt on those parts of the creation which are diminutive, that the insect tribe has been almost overlooked in his searches after knowledge. His ignorance, the consequence of this contemptuous neglect, has led him to consider the whole class as of small importance, and to arraign the Creator for forming a useless, and in many cases offensive

and injurious tribe of beings. Such can be the language only of "haughty ignorance;" the modest observer of Nature, although he may have learned little of the habits, economy, and uses of insects, will acknowledge that they have been created with design, and will not doubt but that the design was benevolent. To such a one it will prove a study equally interesting, and, I doubt not, equally useful with that of birds, of fishes, or of quadrupeds.

Not only from the weak and unenlightened, but from the philosopher too, who has studied and admired the more stupendous acts of the Creator, the entomologist has often met with derision, and with ridicule, for examining the structure, the instincts, and the arts of a spider, or a fly. But what is size in the all-comprehensive eye of the universal Architect? As with respect to time, a thousand ages are to him but as a day, and a day as a thousand ages; so with respect to space, the orbit of a world is as the speck occupied by a puceron, or the hundredth part of a drop of water, in which a monoculus can live, and move, and swim. The same wisdom that ordained the revolution of the planets, was requisite to form the butterfly or gnat; for nothing short of infinite skill could have contrived the spiral trunk of the former, to suck up, as with a syringe, the honey of the full-blown flower, or its elegant colourings, com-

posed by an infinite number of minute variously-painted feathers, artfully arranged; and nothing less could have endowed it with instincts for depositing its eggs on plants, or in situations best adapted to secure the birth, and to furnish with food the embryo caterpillars. Why, then, should we depreciate any part of Nature's works, or cast an opprobrium on the study of any of its branches?

The general opinion, that insects act a less important purpose than any other tribe in the economy of Nature, and that the study of their natural history would conduce but little to the benefit of mankind, I conceive to arise merely from our ignorance on the subject.

I have already said that entomology is in its infancy; if, however, we can now bring a few instances of the importance and utility of the study, we may hope that a further acquaintance with it will discover further benefits; and for this reason I particularly recommend it as an important pursuit.

Blights, both in our orchards and corn-fields, have almost universally been attributed to some peculiar action of the elements; but they have lately been discovered to be owing to myriads of minute insects, often of the puceron kind. Who can tell but that

an accurate knowledge of the natural history of this insect may enable us to prevent its future devastations? How often does our ignorance lead us to destroy insects as injurious, which are altogether harmless, and perhaps even serviceable to us in various ways.

To diffuse the little knowledge that I have acquired, and to stimulate others to engage in this hitherto neglected path, I shall dwell rather longer on the subject of entomology, than on any of the preceding departments.

Insects are characterized by Linnæus as having two antennæ, or, as it is anglicised, feelers: these are moveable appendages affixed to the head, of different forms in different insects, the precise use of which is not ascertained; but probably, as the English name denotes, they are endowed with an accurate sense of feeling, for the purpose of directing the animal, especially in entering holes and crevices. Insects have six or more feet, a hard or boney covering, and breathe through pores arranged along their sides.

Though insects are the smallest of animated beings, yet their variety, and the number of individuals of each species, make them to occupy a larger share

than any other class, in the list of Nature's works: they are to be found in almost every situation, in air, water, and in earth; in wood, in and upon other animals; in decayed vegetables, and in putrid flesh. Their manners and their appearances are as various as their situations; but what we have to observe of them in particular, will be done when considering their separate orders, which we shall enter upon as soon as we have noticed their generation and metamorphosis.

Most insects are oviparous, and in most there are only two sexes, the male and female; but to both of these cases there are a few exceptions. The puceron, or tree-louse, is viviparous, and has other peculiarities in its process of generation, which I shall notice elsewhere. In the bee, the ant, and perhaps some other insects, which live in societies, and unite their labours, besides male and female, there are neuters which are of no sex, and on whom the labour of procuring food chiefly devolves: the common working bee is of this kind; whilst the drones, which are the males, and the queen bee, which is the only female, are alone engaged in the task of procreation.

The eggs of insects, like those of fish, in very few